LITERATURE.

An Exposition of the Errors and Fallacies in Rear Admiral Ammon's Pamphlet entitled The "Certainty of the Nicaragua Canal Contrasted with the Uncertainties of the Eads's Ship Canal." BY E. L. CORTHELL, C. E., 8 vo. 52 pages.

On page 150 of this journal we briefly reviewed Captain Eads' description of Mr. Corthell's paper, read before the American Society of Civil Engineers in connection with Mr. Corthell's statement before the House Committee on Commerce and Rear Admiral Ammen's Pamphlet, to which the pamphlet now under consideration is a reply.

Mr. Corthell opens with the statement that will command the assent of all his readers however they may differ from him as to the relative advantages of the two routes. "It is to be regretted that an officer of high rank in the United States Navy should descend to such undignified personalities as appear throughout the recent pamphlet of Rear Admiral Ammen," etc, and proceeds to discuss the economic and engineering questions involved, and to refute several of the Admiral's statements, without any thing worse than, in noticing Admiral Ammen's charges that he had overstated the length of the Nicaragua Canal. "It is not to be expected that any one can acquire full knowledge of the various plans, surveys, and estimates which Admiral Ammen is in the habit of making of the Nicaragua Canal route."

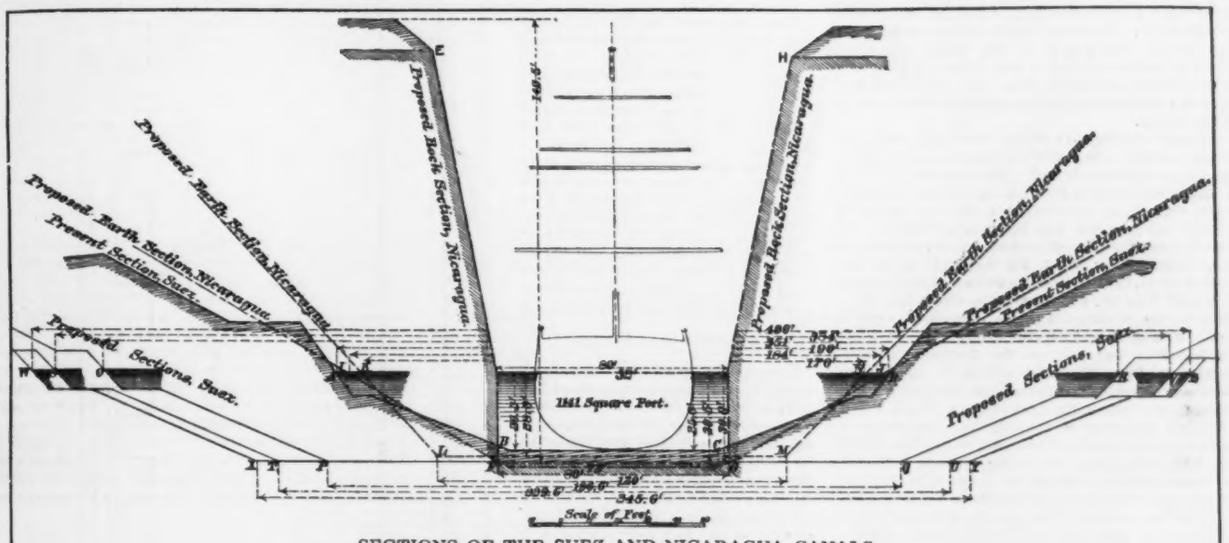
Exceptions are taken to the profile shown in the Admiral's pamphlet, as it was taken from General Barnard's uncompleted survey made thirty five years ago, and the point is made that as the Chivela and Tarifa Passes are ten miles apart, and are totally distinct passes through the same chain of hills, both would not be used by the same road. As Mr. Menocal's letter was incorporated in the text of the pamphlet he answers, Mr. Corthell incorporates portions of Mr. Van Brocklin's report and a letter from him, the first saying that the maximum grade is 52.8 feet per mile and the other certifying that a line can be traced across the Isthmus that will give a profile as irregular in surface as the one furnished" (by Admiral Ammen) adding: "It seems incredible that a person of the prominence of Rear Admiral Ammen would undertake to seriously discuss so important a problem as the practicability of the construction of a railway for the transportation of ships across the Isthmus of Tehuantepec, while so lamentably ignorant of the physical conditions existing on the line located for it."

In the matter of harbors Mr. Corthell is undoubtedly a long way ahead of the Admiral, for instead of having discussed those heretofore considered necessary appendages of a canal as considerably too costly and unnecessary, he is able to state that careful surveys, plans and estimates have been made under his own supervision, and it will be admitted that he is competent to make them.

The estimates both as to cost and size of the Nicaragua canal are taken up and discussed at length, the latter by aid of a diagram which is reproduced, as it gives information regarding the Suez canal not generally attainable, and the cross-section through the supposed rock cut at the "divide' gives one a graphic representation of the difficulties of navigation through it. This cut is about three miles long with an average depth of 149½ feet. Another has a depth of 318 feet. If the material in these cuts is rock, the quality and cost of excavation can be estimated with some degree of certainty, but if, like the Culebra cut, it approaches hard pan in quality neither the quantity nor cost can be predicted.

No one *now* would admit the sufficiency of Major McFarland's estimate for labor at $1.00 per day, as it could not cost much less than at Panama if the canal were to be built with any speed, but a consideration of this kind in view of the hasty character of Mr. Menocal's reconnoisance is a little like figuring the ashes to three places of decimals when you have "guessed in" the coal.

Captain Eads' review of the correspondence between General Grant and himself, an extract from which Admiral Ammen printed in his pamphlet, occupies twelve pages, and seems to put the Admiral very decidedly on the defensive. General Grant did write to Captain Eads that he had been deceived, should oppose the bill in its then form, and would send a copy of his letter to Senator Miller. Captain Eads then wrote to him explaining the matter, which satisfied General Grant, and he sent a copy of the Captain's letter to Senator Miller. It will seem to engineers, at least, that if one letter was referred to the other should have been mentioned.



SECTIONS OF THE SUEZ AND NICARAGUA CANALS.

DESIGNATION OF SECTION.	SURFACE WIDTH IN FEET.	BOTTOM WIDTH IN FEET.	DEPTH IN FEET.	AREA OF PRISM IN SQUARE FT.	RATIO OF CANAL PRISM TO SHIP SECTION.
ABCD—Suez—Present—Rectilinear	190	72.0	26.2	8577.5	8.135
OPQR " Enlargement "	334	196.6	29.5	6962.0	7.030
STUV " " Curves over 8200' Radius	284	229.6	29.5	9863.1	7.943
WXYZ " " " under " "	400	345.6	29.5	9535.1	8.357
KFGH—Nicaragua—Rock cut	80	80.0	30.0	2400.0	2.103
IFGJ " Earth "	184	80.0	30.0	3960.0	3.471
KLMN " " "	174	120.0	28.0	4116.0	3.607

Better Country Roads.

The highway commissioners of the State, in session three days at Springfield, Ill., recently talking about better country roads, finally adopted the following resolutions:

Resolved, That it is the sense of this convention: First, that the primary object of importance to be considered in the repairing of old roads or making new ones is drainage.

Second—All ditches or drains should be made continuous to some natural or artificial outlet of sufficient capacity to readily carry off water that may accumulate in the roadway, and when it is not practical to obtain an outlet for the water on the line of road within the township, the ditches or drains should be extended to the township line and continued by the next township to some natural outlet.

Third—All road grading should be uniform; that is crowning in the center with the greatest depression at the back side of the ditches which should be uniform and continuous, the height and width of the grade to be so regulated according to the particular requirements of each location, always keeping in view permanentcy in the thorough draining.

A Bridge Question.

To the Editor of Engineering.

SIR.—I have to render you my hearty thanks for valuable assistance on two occasions. First, for your foot-note to my letter published October 10, 1884, which enabled me to expose a dangerous bridge. Second, for inserting my questions on testing iron in your issue of April 24, 1885, which questions, though unanswered, have led to a great and most valuable reform in the practice of one of our leading Government departments.

I now crave your opinion with respect to the subjoined problem as one involving public safety to a most serious degree:

Road Bridge at Queanbeyan, New South Wales

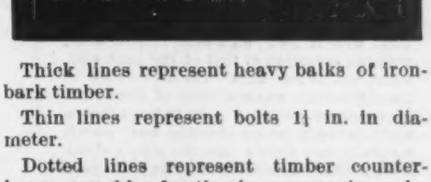
Clear span, 70 feet.

Width of road, 18 feet.

Weight of timber and iron in bridge, 40 tons.

Live load at ¾ cwt. per square foot of deck, 47 tons.

This weight is delivered by numerous cross girders on the bottom members of two trusses of the annexed form. Depth of truss, 10 feet.



Thick lines represent heavy balks of ironbark timber.

Thin lines represent bolts 1¼ in. in diameter.

Dotted lines represent timber counterbraces capable of acting in compression only.

A B represents *a single bolt* made of 1¼ in. round iron not enlarged at the screwed part, and having a net sectional area inside the screw of not quite 1 square inch.

What is the stress on this bolt, and is the bolt large enough to endure it?

Yours truly,

W. C. KERNOT.

University of Melbourne, March 4, 1886.

Davis Island Dam, Ohio River.

Written for ENGINEERING NEWS.

BY WM. MARTIN, ASST. U. S. ENGINEER, PITTSBURG, PA.

General Description.

The Chanoine dam at Davis Island, is the first of a series of movable dams devised for the radical improvement of the Ohio river. It is located five and a half miles below Pittsburg, and is designed to make slackwater between the dam and Lock No. 1. on the Monongahela river, and on the Aliegheny river to Thirty-sixth street, two and a half miles above its mouth.

The lock is located on the north side of the Ohio. The distance between the gates of the lock is 600 feet, and the total width of the lock is 110 feet. The noteworthy difference between this and ordinary locks, is in the employment of rolling instead of swinging gates, and in the construction of recesses for the reception of the gates when open. These recesses, or slips, are built towards the shore, from the lock, a distance of 120 feet. The total length of the river lock-wall is 689 feet. The wall is 11 feet thick, and has a height of 17 feet above, and 2½ feet below the gate sill, making a total height of 19½ feet. The land wall (including the development of the recesses for the gates) is 1,169 feet long.

The movable dam begins at the river lock wall, at a point 100 feet above the lower lock-gate, and extends to the abutment on Davis Island. The dam is 1,223 feet long, and is composed of 305 wickets, divided into four sections, viz.: First, the Navigable Pass, 559 feet wide which has one hundred and thirty-nine wickets, the distance between centers of wickets being 4 feet and ¼ inches. Second, Weir No. 1, 224 feet wide which has fifty-six wickets, the distance between centers being 4 feet. Third, Weir No. 2, 224 feet wide, which has fifty-six wickets the distance between centers of wickets being 4 feet, and Fourth, Weir No. 3, 216 feet wide, which has fifty-four wickets the distance between centers being 4 feet. The main sills of the weirs have the following reference to that of the Navigable Pass, Weir No. 1, 1 foot above, No. 2, 2 feet above, No. 3, 3 feet above. This stepping of the sills was necessary in order to make the profile of the dam to conform to the natural bed of the river. The perpendicular height of the Navigable Pass from the sill to the crest of the dam is 12¼ ft. 1¼in. while the height of the weirs is respectively 1 foot less corresponding to the stepping of the sills referred to. The crest of the dam forms one unbroken line from the river lock wall and at right angles thereto, to the abtument on Davis Island. Piers are constructed at the junction of the Navigable Pass and Weir No. 1, and at the junction of the weirs. The lower end of these piers is 20¼ feet further up the stream than the crest of the dam. The use of these piers will be explained in connection with the service bridge.

Seven years and nineteen days were consumed in the construction of the dam. Work was begun August 18, 1878, and completed October 7, 1885, when the dam was formally opened, with a grand public demonstration combining civil and marine displays.

Fig. 1, is a general plan showing the lock and dam, Davis Island and the permanent dam from Davis Island to the south shore of the river. Fig. 2, is a general plan of the lock. Fig. 3, is a cross-section of a gate recess, (through a valve) and Fig. 4, is a cross-section of the movable dam.

Mode of Construction.

The coffer dams required for the entire work were seven in number, viz.: one enclosing the land lock wall; two enclosing the river lock wall; one enclosing the navigable pass; one enclosing the weirs, and one at each end of the lock enclosing the lock chamber. The general dimensions of the cross sections were 12 feet high and 12 feet wide, with the exception of that of the land wall, which was 14 feet high. The framework of the coffer-dams was composed of three rows of stringers on each side, 12 feet 4 inches apart, between which sheeting was placed vertically, and driven into the gravel about 2 feet. The joints of the sheeting were covered with batting 6 inches wide, and 1 inch thick, to retain the puddle material. As the framework was constructed, workmen filled in the puddle material, a fine loam procured on Davis Island, and transported across the river on flatboats. The stringers were placed at the centers of pressure of rectangles of equal pressure, and united by a scarfed joint with an iron rod passing through the entire width of the coffer dams, and supplied with a nut and washer on each end. The total length of all the coffer-dams was 5,445 feet. All were made in the manner described except that enclosing the site of the navigable pass, the puddling for which was pumped in liquid form through a pipe from Davis Island. The pump which was of the ordinary centrifugal type was placed on Davis Island 900 feet from the coffer-dam. A tank 8 feet in diameter and 4 feet deep was placed a sufficient distance below the pump to insure a fall for a water culvert from the river. The loam was delivered into the tank by "horse scrapers," and after being reduced to the consistency required by the admixture with water, was taken up by the pump, and forced through the delivery pipe to the coffer dam, which at the commencement was 900 feet distant, but as the puddling progressed, the distance increased until the total length of the delivery pipe was 1,300 feet. The liquid material deposited in the framework flowed several hundred feet, forming a hard solid mass. It penetrated every crevice in the framework, and required neither watering nor ramming. The process separated the material as found on the island, and the loam being the lighter body was kept longer in suspension, and finally settled on top of the sand.

Alignment and Levels.

In establishing the base line from which references to all parts of the work were made, two permanent targets were set; one on the hillside on the north side of the river; the other on Davis Island. This line was called the "construction line," and from an arbitrary point on this line, the zero of all measurements parallel with the crest of the dam were started, and every important point in the lock and dam is expressed by reference to this line, as a station on the line, or to the right or left of it. For instance, the face of the land lock wall is station 220 feet, that of the river lock wall 330 feet, etc., The lower face of the upper gate recess is 273 feet to the left, and the upper face of the lower gate recess is 327 feet to the right. The crest of the dam is 227 feet to the right, etc.

The levels were taken above mean ocean level; the crest of the dam, or the normal level of the pool, has a reference of 705.125 feet above this level and corresponds to the 6-foot stone mark on the Market street gauge, of the Monongahela wharf at Pittsburg.

To test the accuracy of the levels, and to determine the correctness of the calculations, a reading was taken at the Market street gauge when the dam was up, and the water at the normal level of the pool. The gauge indicated 6.15 feet, practically demonstrating the accuracy of the levels. As it is natural that there should be some fall between Pittsburg and the dam, the gauge reading of 6.15 feet would make the fall in a distance of 5.50 miles, 0.15.

Excavation.

After the coffer dam enclosing the site for the land and recess walls was completed, the work of excavating for the foundation was begun. The bed of the river at the site of these walls is an argillaceous rock, which was excavated to a depth of nearly 15 feet at the rear of the recesses made for the gates. From this point the rock dipped toward the lock, until at a point about 50 feet beyond the face of the land wall it disappeared beneath the lowest point of the foundation. The excavation for the upper walls of the recesses was made to conform closely to the inner line of the cross-section, to a height

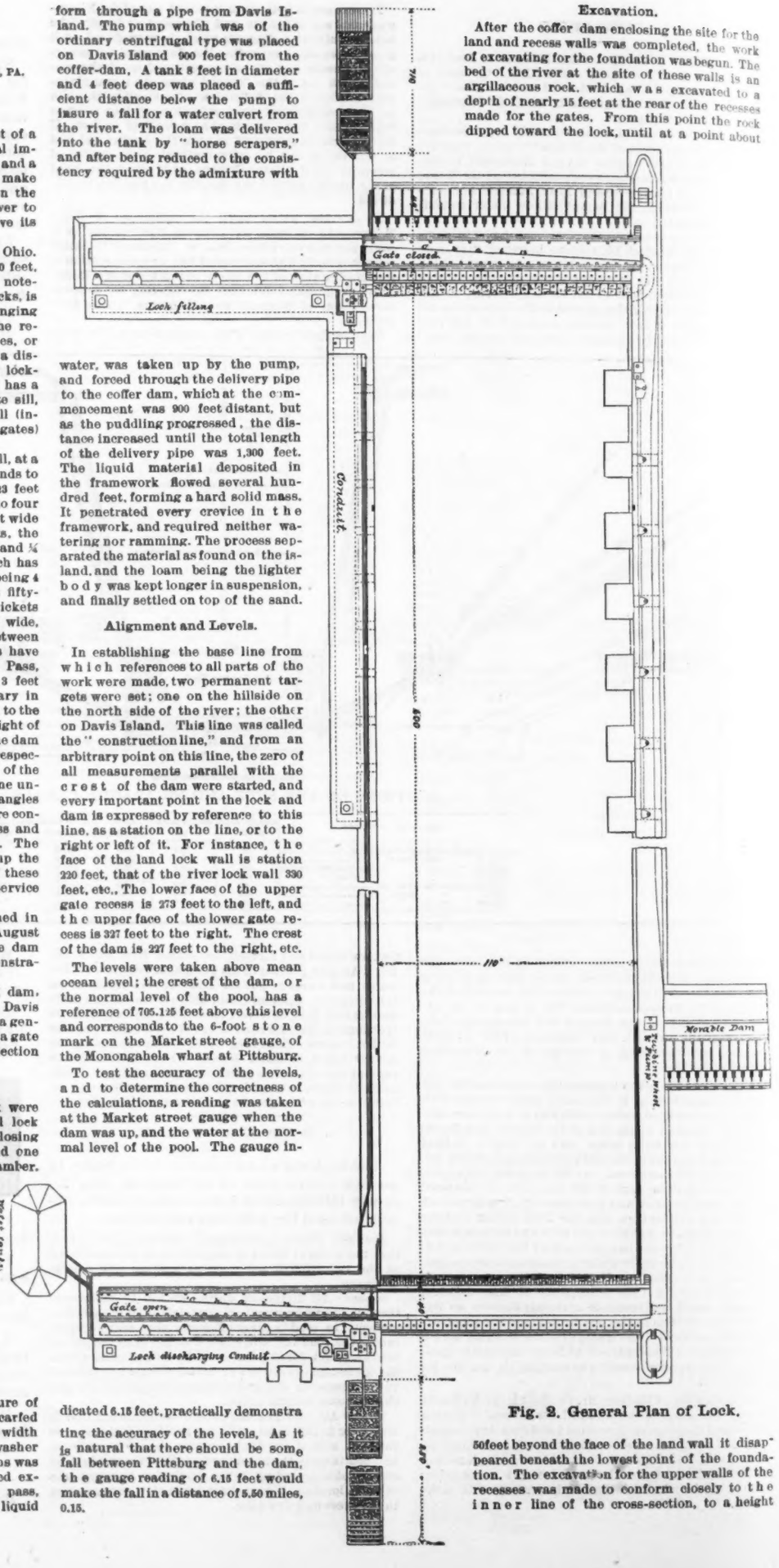


Fig. 2. General Plan of Lock.

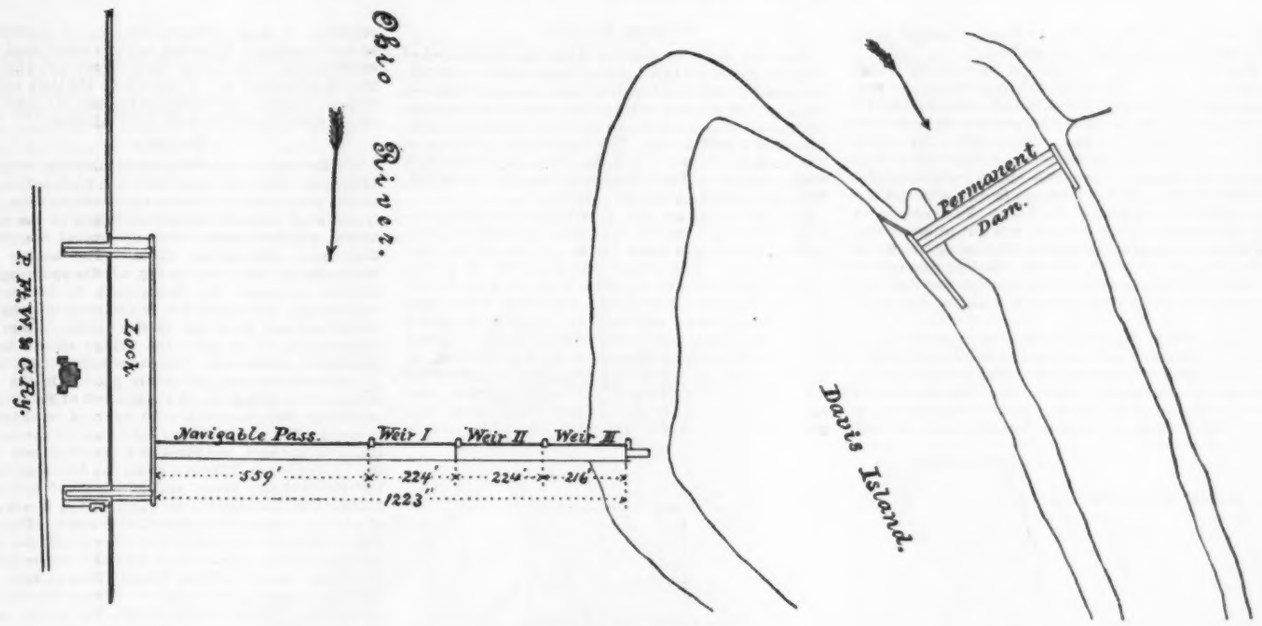


Fig 1.—General Plan.

on a level with the natural bed rock of the river. It was necessary to excavate nearly 7 feet below the gate sill for the ashlar masonry of the valve chambers, placed in the lower walls. The excavations for the recess and land walls were carried on simultaneously, and the masonry followed as rapidly as the excavation was completed. The masonry of the land and recess walls is composed of small and large rubble work, and regular ashlar. The recess walls are built of the two classes of rubble masonry, the lower walls from a point $\frac{4}{10}$ feet above the gate sill to the bottom of the coping being composed of large rubble, while the entire upper walls, to the bottom of the coping, are built of small rubble. These two classes of rubble masonry were constructed to ascertain the comparative cost of rick. As the masonry was completed within the radius of the boom, the derrick was moved forward to a new position.

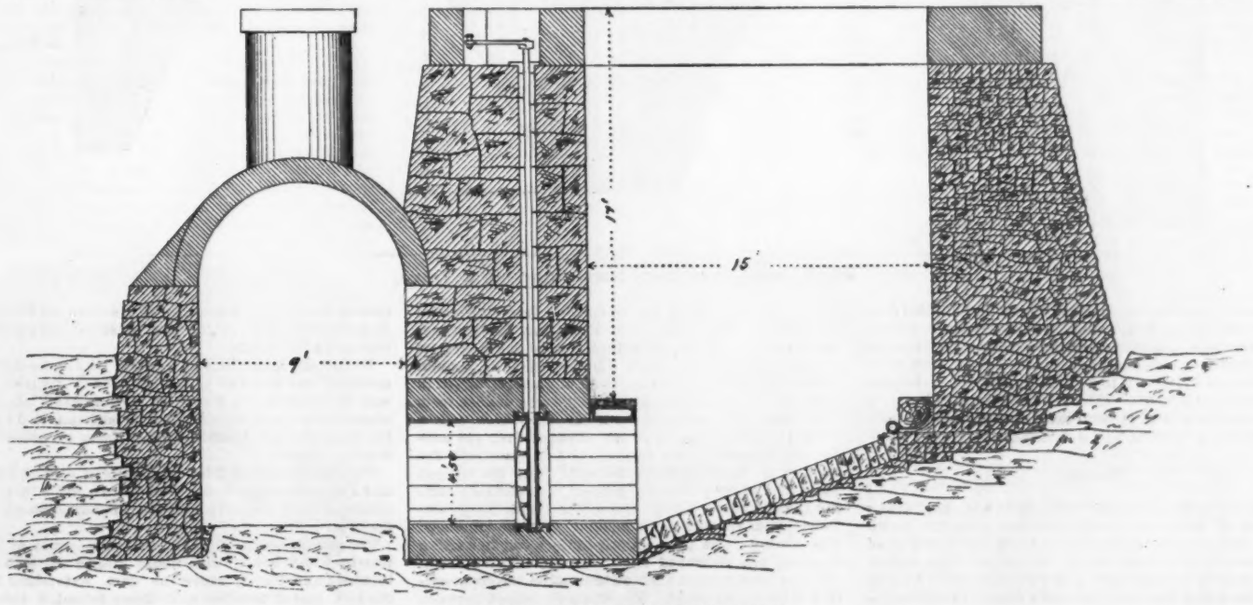
Foundations.

In selecting foundations for the land and recess walls, the gates, the chanoine dam at the head of the lock, and the river wall, borings were made to determine the depth of rock. As before stated, the land and recess walls are built on an argillaceous rock, which was excavated to the lower course of masonry: at a point 50 feet outside the wall, the rock disappeared below the lowest point of the foundation. On the site of the river wall and dam proper, no rock could be found at a depth of 15.17 feet in the former and 13.58 feet in the latter below the gate sill. Instead of the rock a compact gravel was found which could hardly be penetrated by a pick. As this depth was deemed below any possible scour, it was decided to build on the gravel. The foundation for the river wall and dam proper was begun at the reference below the gate sill already given. This foundation (composed of concrete) was carried up, for the river wall to a reference of 2.50 feet below the gate sill making a depth of concrete of 12.67 feet, while the foundation for the dam was carried up to a reference of 1.58 feet below the sill of the dam, making a depth of concrete of 12 feet.

In the foundation of the gate and of the chanoine dam at the head of the lock, the bottom of the concrete was carried level at the reference of 15.17 feet below the gate sill, until it intercepted the rock at a point 50 feet outside the land wall. From thence to the land wall the depth decreased with the rising inclination of the rock, terminating at the land wall at a depth of 2.75 feet below the gate sill. From this depth to the full height it was finished with the timber gate sills, and stone masonry.

The track sills on which the gates travel across the lock are built in the solid masonry, and are anchored deep in the concrete (or solid rock, as the case may be) by bolts 1¼ inches in diameter, placed at intervals of 4 feet and ¾ inches. The lower ends of the bolts are provided with discs 18 inches square, which prevent the bolts from being pulled through the concrete. As the rock (which has a rising inclination) is intercepted each successive bolt becomes shorter; to secure anchorage equal to those placed at the full depth of the concrete, the points of the shorter bolts were split, and secured by a fox-wedge in a hole drilled in the solid rock. The shorter bolts are also provided with discs similar to those placed on the bolts having the full depth of concrete.

Two large white-oak timbers, placed 11 feet 6 inches apart, and held in place by the bolts referred to, form the gate track sills. The upper sill is 18 inches square; the lower, 23 × 25 inches. In the top of these sills a rabbit is cut, in which the track iron, 1 inch thick and 6 inches wide is laid. The lower edge of the upper and the upper edge of the lower is protected by angle irons



Cross-section of Movable Dam.

the quantity laid per man per day, which was as follows: large rubble, 4.30 cubic yards; small rubble, 3.50 cubic yards, a difference of 0.80 cubic yards per man in favor of large rubble.

Derricks.

The ashlar and large rubble masonry was handled by a double derrick, or the style of derrick rigged with the fall and runner lines. This derrick requires two crabs or winches, one each for the fall and runner. With this derrick the boom can be set at a convenient angle, and does not require changing on account of the distance from the mast to the stone set. In its operation it is slower and more complicated than a single rigged der-

preventing abrasion by the washing of gravel, sand, etc., caused by the wheels of steamers.

The floor of the gate foundation between the tracks (across the lock), which is 14 inches below the rail, forms a cavity in which it was feared gravel and debris would accumulate in quantities which would interfere with the passage of the gate. Inspection of this cavity after a winter's rest of the gates, during which time masses of ice passed over the sills, showed that the debris collected did not interfere in the slightest degree with the operation of the gates. Furthermore, it was found that as soon as the lock is put in operation, the strong current which rushes between the tracks on its way to the lock filling and discharging valves, located in the lower walls of the recesses (see Fig. 3 *A*) frees the cavity of all the debris which may be deposited there.

By reference to Fig. 3, which shows a cross-section of the gate recesses, it will be seen that the foundation of the lower walls of the recesses are deeper than those of the upper, while the gate tracks are on the same level. This depression of the lower so much below the upper wall, with the sloped pavement between them, is made

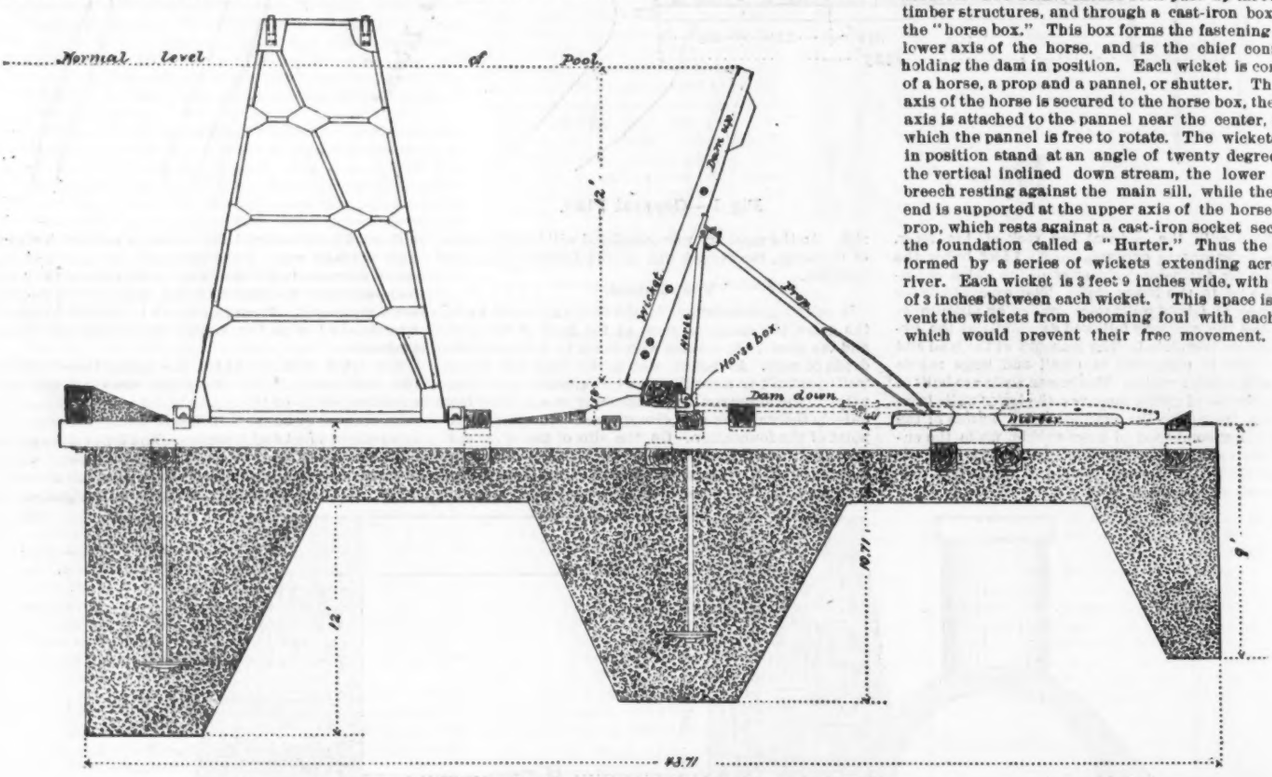


Fig 3.—Section of Gate Recess through a Valve.

to give a waterway to the lock, filling and discharging valves which are in this wall. These valves are circular in form, with the intrados 5.29 feet below the gate sill. The lower wall in both recesses is ashlar work from the bottom of the wall to a point 0.87 feet below the gate sill (or a height 7.83 feet) from thence to the bottom of the coping the wall is composed of large rubble work, the stones averaging half a cubic yard.

Pumps.

The enclosures of all the coffer dams were kept dry by means of one or more 10-in. centrifugal pumps, which were sunk in a pit to a depth low enough to insure good drainage from all parts of the enclosures. The pumps were driven by belts from a horizontal engine located on a level with the top of the coffer dam. These pumps were capable of discharging 2,200 gallons of water per minute lifting it a height of 34 feet.

Traveling Derrick.

In handling stone and other material for the construction of the stone masonry of the river lock wall, the stationary derricks used on the land and recess walls were abandoned and a traveling or locomotive derrick was used which ran on a track of 8 feet gauge. This machine was capable of handling with ease stone masonry 3¼ cubic yards. Its movements were so rapid that it gave employment to three gangs of masons, transporting the material half the length of the wall. The extraordinary progress made with this derrick demonstrated its superiority over the ordinary stationary derrick, in constructing masonry walls of great length.

Concrete Masonry.

A portion of the foundation of the dam at the head of the lock, and of the gates, that of the dam proper extending from the river wall to Davis Island, and the river lock wall, in all which rock could not be reached at a reasonable depth, were built upon a concrete foundation, resting upon a hard gravel. The foundation of the dam at the head of the lock and of the gates, follow the rock until a reference of 15 17 feet below the sill was reached. This level was preserved throughout.

The concrete mixer was placed on an elevated platform 15 feet high, erected convenient either to the lock walls or to the coffer dams, for the purpose of facilitating the work. The cement was conveyed by a two-wheeled hand truck by laborers, from the Fort Wayne railway, which is parallel with, and 177 feet from the lock. This elevated platform was situated in such a manner that the cement could be wheeled into it direct from the cars without the necessity of rehandling. A strong square wrought-iron hopper was constructed on the center of the platform in such a manner as to convey the material into the mixer. The cement was mixed to a thin paste in two trays, hinged on the side of the hopper. When the cement was deposited on the platform by the truckmen, it was taken in its proper proportions, and mixed with water to the degree of consistency required, then dumped into the hopper. Simultaneously the broken stone and gravel mixed in their proper proportions were hoisted by a derrick from the coffer dam enclosure in a skip, provided with a hinged bottom. This skip was elevated over the hopper, the hinged bottom dropped, and the contents deposited in the hopper, at the same time the cement paste was dumped unto the hopper, thus partially mixing the elements before the mixer began its revolutions. Four revolutions sufficed to mix the elements. The concrete was then emptied into a car in waiting beneath, and conveyed on a tramway to the place in the excavated trench, sheeted to confine the cross-section to its proper shape. The concrete placed between the sheeting in layers of 6 inches, was thoroughly rammed with a thirty-four pound rammer, until a water flush appeared on the surface, and permitted to thoroughly set. The workmen in the meantime advanced several hundred feet on the course started. By the time they advanced this distance, the beginning of the course was thoroughly set. This operation was repeated, until the proper height for the commencement of the stone masonry was reached. The absence of any automatic devices for measuring, required the utmost vigilence to preserve the proper proportions in laying the concrete. Extraordinary care was required to secure the proper consistency in mixing the concrete. More than the requisite amount of water made it too soft, prolonging the time required to set, and delaying the second course; the insufficient amount of water rendered the concrete less homogeneous resulting in an inferior product. A mean between the two, or a mixture of such a consistency as would bring a water flush to the surface by the time it was rammed well into place, was the object aimed at. A record of the time required to make a batch of concrete (an average of a cubic yard) shows that it varied from 2¼ to 3¼ minutes.

The Dam.

The floor of the dam is a framed structure composed principally of 12 × 12 inch white-oak timbers framed in such a manner as to form a rigid combination. This frame-work was built in the foundation at the proper height, and the concrete built up around the timbers thoroughly imbedding them. The anchor bolts (shown in the cross-section Fig. 4,) pass up through the timbers, securing the frame-work to the concrete foundation. The upper bolt is designed to resist any strain imposed upon the service bridge, either from actual work, or in case the bridge should become clogged by drift-wood. The lower bolts, (there is one to each wicket) holds the dam in place. On the foundation thus prepared, and composed of the concrete anchorage and frame structure referred to, the dam is secured. The wicket anchor bolts pass up through the timber structures, and through a cast-iron box called the "horse box." This box forms the fastening for the lower axis of the horse, and is the chief connection holding the dam in position. Each wicket is composed of a horse, a prop and a pannel, or shutter. The lower axis of the horse is secured to the horse box, the upper axis is attached to the pannel near the center, around which the pannel is free to rotate. The wickets when in position stand at an angle of twenty degrees with the vertical inclined down stream, the lower end or breech resting against the main sill, while the upper end is supported at the upper axis of the horse by the prop, which rests against a cast-iron socket secured to the foundation called a "Hurter." Thus the dam is formed by a series of wickets extending across the river. Each wicket is 3 feet 9 inches wide, with a space of 3 inches between each wicket. This space is to prevent the wickets from becoming foul with each other, which would prevent their free movement. These spaces during very low stages of the river can be closed if necessary, thus saving the water to maintain the pool at its full height.

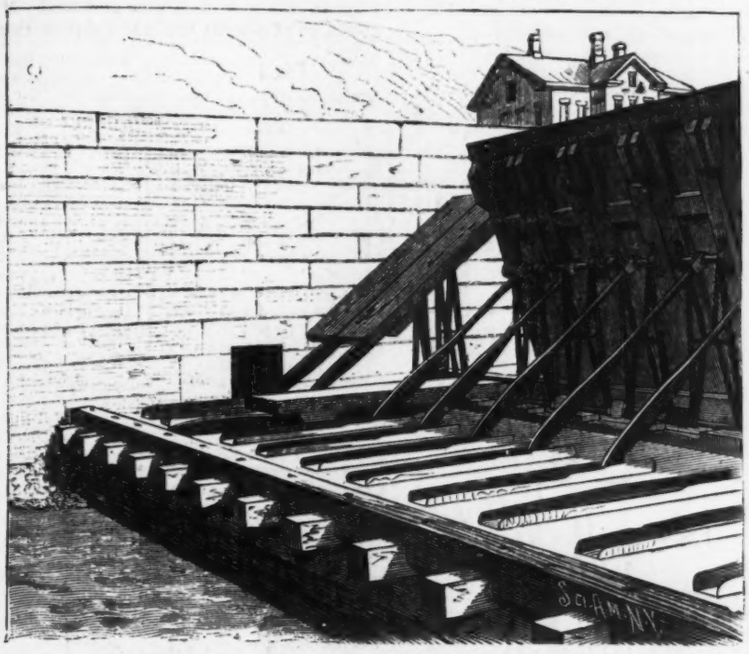
The arrangement by which each wicket is held in position and lowered to the bed of the river at will, may be described as a sort of folding joint; all parts when lowered assume a horizontal position, and lie below the main sill, insuring safety from steamboats or floating objects.

The dam is operated by means of a service bridge and a manœuvering boat. The three weirs are manœuvred from the service bridge, the navigable pass by the boat.

The service bridge is composed of a series of light trestles 8 feet apart, with floors hinged to them, and located immediately above the dam, extending from the lock end of weir No. 1, to Davis Island, a distance of 664 feet. These trestles are so arranged that when not in use they lie in a recess or chamber in the foundation prepared for them. The floors hinged to them, forming connecting links between each trestle when in position, fold on top of the trestles. When the trestles are drawn up with the floors connected, they form the frame-work of a bridge, extending from the lock end of weir No. 1, across the river, parallel with the dam to Davis Island.

When the service bridge and wickets of the dam are all down, and it becomes necessary to raise the dam, the first step is to draw up the trestle nearest the shore. This is done by means of a chain attached to it. The power employed is a trestle wrench which runs on a track formed by the connecting floors of the trestle. When the first trestle is drawn up and its floor fastened, it forms the first section of the bridge; the

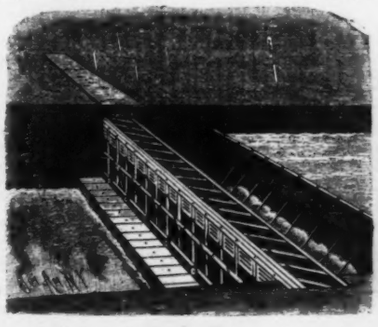
winch is then advanced on to this section, and the second trestle is drawn up, and its floor fastened. This operation is repeated until all the bridge is raised. The piers referred to, at the junction of the weirs are for the purpose of steadying the service bridge; the method employed to support the bridge is attended with the disadvantage that, if the first fastening at Davis Island should break, the whole bridge would fall. These piers render the bridge of each weir self-supporting, and prevent transmission of the strain from one weir to another. The service bridge being raised-everything is in readiness to raise the dam. The



View from Below Showing the Wickets in Different Positions.*

operation of raising the dam is accomplished by another winch (called the wicket winch) the axis of which is parallel to the dam.

To the breech of each wicket is attached a chain which is connected with the trestle, and has been brought up with it from its recess in the foundation. This chain is used to draw the wicket from its position when down to its position when raised. When the wicket is lying down all the parts assume a horizontal position; when the power is applied to the winch the wicket rising, feathering to the current until it is drawn to its position, when the prop drops into the socket of the hurter, which makes a ringing sound. This is a signal for the workmen at the winch to stop, the



Upper Gate and Shore Recess.*

chain is slacked up, and the drop rests firmly in its seat. The wicket which so far has assumed a horizontal position now requires to have the breech lowered to its bearing against the main sill in the foundation. When this is done the first 4 feet of the dam is completed; the winch is then moved forward to the next wicket, and the operation is repeated until all the wickets are raised.

As before stated only the weirs are manœuvred from the service bridge, the navigable-pass being worked by a manœuvering boat. This boat is made of steel, is 36 feet long, 10 feet wide and 2 feet 6 inches deep. The wicket winch is located in the center of the boat; the line from the winch by which the wickets are raised changes its direction by passing over a steel sheave mounted at the bow of the boat.

*Reduced from cuts in the *Scientific American*.

Eight outriggers suspended on the side of the boat serve a double purpose: forming a platform for the workmen and keeping the boat far enough from the face of the dam to permit the breach of the wicket that is being raised to swing past the sheave to its seat against the main sill of the dam. On the outer ends of the two forward outriggers a buffer 4½ inches thick, 12 inches wide, and 6¾ feet long is fixed, which rests against the wickets raised. These buffers have a high and low position, the former for working in low water, and the latter in high water. This is for the purpose of keeping the point of bearing on the wicket below the axis of rotation, to prevent the wicket swinging when the pressure required to raise a wicket is brought upon it. The line from the winch in the boat has a manœuvering pole attached to the end of it; the end of this pole has a hook with which the operator grapples the wickets. The location of the wickets sought, can be almost definitely fixed by the one last raised; rarely has the hook to be cast more than twice. The wickets in the Navigable Pass are the same as those in the weirs, except in the matter of size, and the same rules which govern the raising of those on the weirs apply to those on the Pass.

In lowering the dam it is only necessary to catch a wicket at the top, and draw it forward until the prop drops off of an inclined step on the hurter; the wicket is then released, and the pressure of water against it forces the prop into the downward channel of the hurter; when the wicket falls gently, and without any shock into its position in the bed of the river.

In lowering the dam, after all the wickets are down the service bridge is also lowered, thus giving the channel of the river an unobstructed passage.

Hydraulic Machinery.

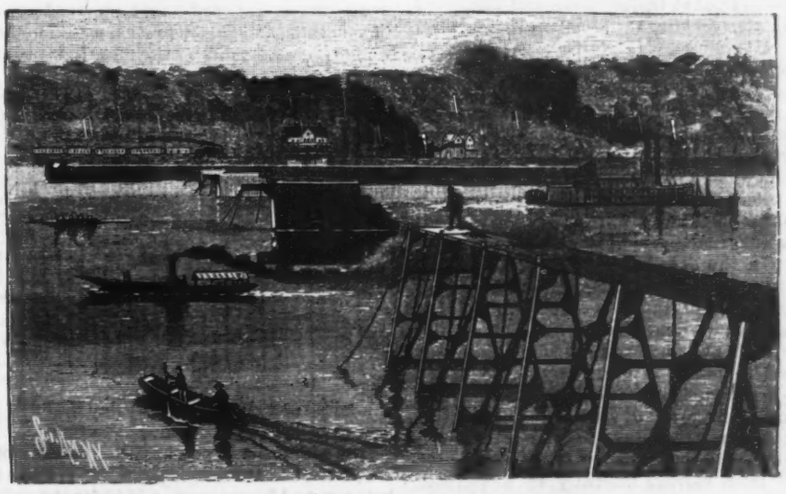
Hydraulic power is employed to operate the lock gates. At each gate a combination of machinery is arranged admitting of two speeds so that the power may be quadrupled if necessary. The machinery for the upper gate is operated by a 6-inch turbine wheel; the lower gate by a 9-inch wheel, each wheel working under a minimum head of 44.5 feet, and a maximum of 60 feet. The power is communicated to the gates by a shaft carrying a chain drum, on which a spiral groove is turned. Two chains are attached to this drum, one of which is fastened to each end of the gate. The length of one chain fills the groove; as one chain unwinds the other is wound on the drum. The machinery is made reversible so that the gates can be moved in either directions for the purpose of opening or closing, them. The water for operating the gate machinery turbine wheels is supplied by a pump located in a well in the river lock wall, which is operated by a 25-inch turbine wheel driven by the power the dam creates. This pump elevates the water into two tanks a height of 60 feet, the combined capacity of these tanks is 79,000 gallons.

The lock filling valves, fourteen in number, are circular in form, and 4.50 feet in diameter, they are located seven in the lower wall of the gate recess, and seven in the river wall. The valves in the gate recess discharge the water into a conduit which conveys it for a distance of 232 feet along the land wall, discharging it into the lock through culverts. Those in the river wall discharge directly through the wall, and are located opposite to the culverts in the land wall. The set of valves in each wall are each operated by a hydraulic jack, controlled by the lock-keeper stationed on the land wall. All the valves move simultaneously

The lock discharging valves are twenty-one in number, and are also circular; seven, 4.50 feet in diameter, are located in the recess wall similar to those for filling the lock, and fourteen 3 feet 2 inches in diameter are located in the lower lock gate. The seven in the recess wall are operated by a hydraulic jack similar to those for filling the lock. The fourteen valves in the lock gate are operated by hand.

Ohio River Commerce.

The Davis Island dam gives harborage for 12,000 steamboats and barges. The inland river traffic on the Ohio and other western rivers which is already enormous in volume, and steadily increasing, will be greatly simplified and cheapened when the system of movable dams has received a wider development. The transportation service conducted on the Ohio, and the 20,000 miles of inland navigable waters accessible to the steamers peculiar to Pittsburg and the inland ports directly connected with that city, is so vast that figures fail to convey an adequate idea of the magnitude of the operations. The traffic on the Ohio river in 1874 when a special report was made to the National Govern-



Service Bridge and Piers.

ment, equalled the total foreign commerce of the United States and its value was estimated at $800,000,000. The most important item is coal. At least $10,000,000 is invested in coal barges and in tow-boats, which are steamers built wholly with reference to power, and employed in transporting coal to the lower river ports, and in fact to all intermediate ports between Pittsburg and Cow Island on the upper Missouri, 4,300 miles from Pittsburg. These steamers traverse distances equaling the passage of the vessels plying between New York and the most distant ports on the Baltic sea

Pittsburg coal is delivered in New Orleans, 2,000 miles distant, for $2.60 per ton. About 4,000 vessels of various models are employed in the transportation of coal alone. Upwards of 4,500,000 tons of the 13,000,000 tons of coal mined in the vicinity of Pittsburg in 1883, were transported to the consumers by water. The means by which this commerce can be fully developed, and navigation in the simplest and cheapest form the world has known, can be extended, has been fully demonstrated by the successful working of the Davis Island dam.

This great work was designed and built by Lieut-Col. W. E. Merrill, Corps of Engineers, who is now and has for many years been in charge of the improvement of the Ohio and some of its tributaries. The resident engineers were Capt. F. A. Mahan, Corps of Engineers, from the beginning until August, 1884, (except during the season of 1881 when his place was temporarily taken by Lieut. W. M. Black Corps of Engineers) and by the author of this article who has been connected with the work from the beginning as assistant engineer, and who completed the work and remains in charge of its operation and maintenance.

A Novel Cement Testing Machine.*

BY P. F. BRENDLINGER, ACTIVE MEMBER OF THE CLUB.

For want of a better name, I call it "novel"—perhaps "cheap" would have expressed it better, but then the manufacturers of testing machines would have made the same claim, viz.: that their machines are all cheap; so let it stay "*Novel.*"

I wish to state that I will not even claim equality with cement testing machines made by regular manufacturers, nor will I enter upon the question of how to make cement tests, preparing the briquettes, etc. What I desire to produce is a machine that will test with sufficiently approximate accuracy to be used by all those engineers, contractors and railroad men in general, who will not, or cannot afford to buy standard machines costing about $100. It is a very rare occurrence to see a cement testing machine on a railroad, in fact, not one road that I was ever connected with had a machine.

Immediately after commencing the construction of the Reading and Pottsville Railroad (last spring), cement manufacturers poured into my office at Pottsville, with their wares; as usual each manufacturer had the best brand, and backed up his statements with innumerable testimonials and tabulated statements, showing very fine results. I used some of these cements for a month, and by various crude tests satisfied myself, I was getting a variable cement, some good and some bad. My Prin. Asst. Eng., Mr. Chas. S. Churchill, and I then put our ideas together to construct a cheap testing machine, and the result is what I show by photograph and detailed plan of machine. The photograph shows the machine in working order with all the paraphernalia attached, as it stands in my office. In the detailed plan (Fig. 1) is a side elevation of the machine. The framework consists of an ordinary trestle I found lying around. An ordinary carpenter put on the top or table and made the wooden clamp at the end to hold the briquettes. The upper clamp is made entirely of oak, while the lower is bound with a strap of iron, and holding the spring balance reaching 100 pounds; a lever 5' 1" long, is attached to the lower clamp and is kept from moving laterally by a vertical slot used as a guide in a board near the end of the lever; this insures a square break of the briquette. A small button holds up the lever when not in use. The upper clamp has two brass hooks, which catch in two eyes on the lower clamp, which hold the clamp together while putting in the briquette; then they are uncoupled, and the briquette is broken by means of the lever, etc. The lower clamp has a hole bored through it, into which an iron rod extends fastened to the trestle; this is for the purpose of stopping the fall of the lower clamp and balance after the briquette is broken. There is sufficient play around this bolt, so that no part touches while the strain is applied. The water pan is shown under the machine and is made of galvanized iron.

Fig. 2 shows the plan of the machine. Fig. 3, an end elevation on large scale, and Fig. 4 shows half size of briquette moulds.

FIG. 1

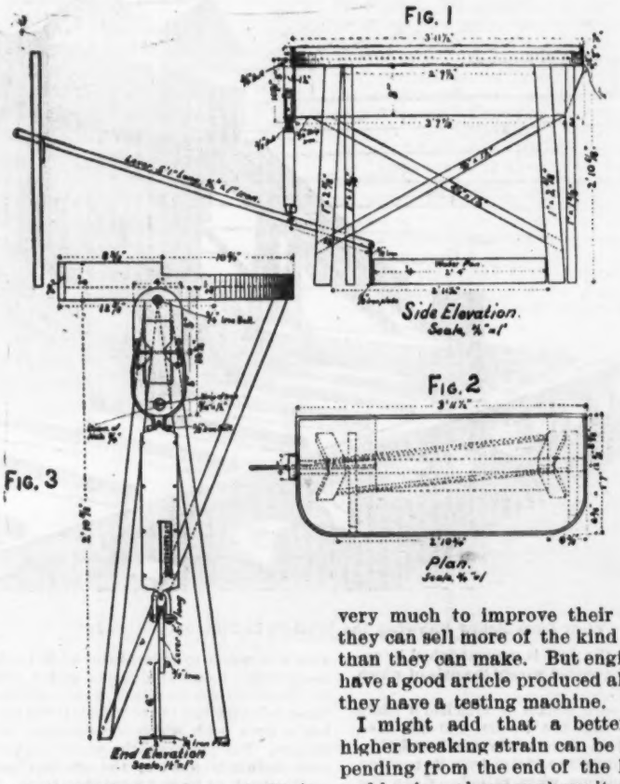


FIG. 2

FIG. 3

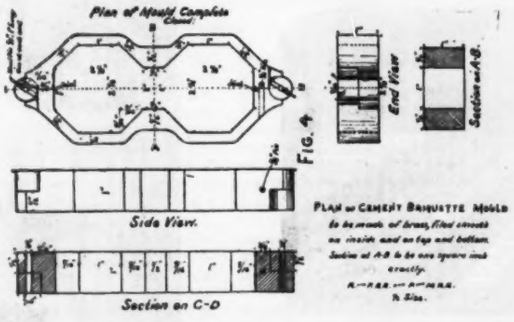
The entire cost of this machine as built is $12, and by a few changes, the cost can be very much reduced, and on roads where carpenters and blacksmiths are constantly employed and paid by the month, a machine can be turned out some rainy day that will not cost over five or six dollars.

To obtain the exact breaking strain of a briquette, the number of pounds is read on the balance, and four pounds added for the weight of the lower clamp and balance. The briquettes are made in two ways: one of pure cement and immersed in water in the pan, and kept there for twenty-four hours, when they are broken; the other, a mixture of two parts sand and one part cement, kept immersed for seven days, then broken. This machine will not show as high results as are obtained from Riehlé's or Fairbanks' machines, but the comparative results between different cements can be just as readily obtained, and when a certain brand is once adopted, the uniformity of the cement can be just as well determined as in a better machine.

There have been over 600 tests made this season in this machine, and I know it would surprise many engineers to look over the pages of the record and see how bad some cement is. I would be glad to see every engineer and purchaser of cement, use a cement testing machine, and wherever the cost has been in the way, it is now removed. Manufacturers of cement will not exert themselves very much to improve their cements, while they can sell more of the kind they have got, than they can make. But engineers can soon have a good article produced all the time after they have a testing machine.

I might add that a better and perhaps higher breaking strain can be reached by suspending from the end of the lever, a bucket, and having a hopper above it, filled with sand or shot, which would run into the pan, and thus put the strain on the briquette gradually. A number of changes could be made to suit the individual as long as the result is reached.

FIG. 4



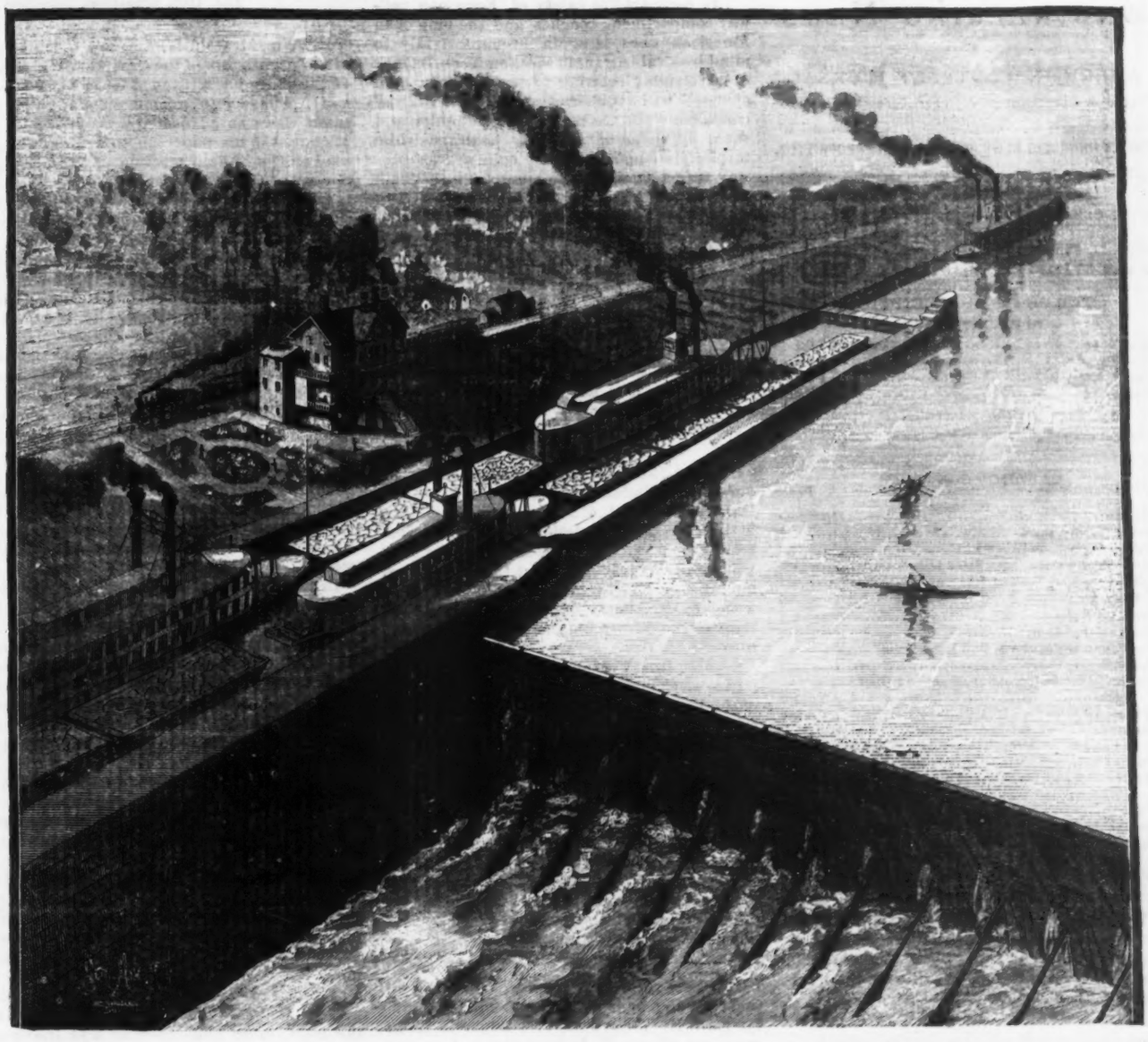
*From the Proceedings of the Engineers' Club of Philadelphia. Read October 17, 1885.

A General Distance-meter.

(Translated for ENGINEERING NEWS from *Les Annales des Travaux Publics.*)

Engineer Sanguet has just invented a new kind of micrometer, which can be easily fitted to the eye-piece of any instrument. It will do a great deal in the way of transforming theodolites of so many kinds into tacheometers, and thus allow the instruments already in use to be further utilized and so advance the development of tacheometry.

The invention consists in taking the cup which serves as a cover to the eye-piece of a theodolite and almost completely hollowing out the bottom, and then fixing on the remain-



General View of the Davis Island Dam. (*From Scientific American.*)

ing ring another ring of a peculiar shape. This ring may be hinged, as in Fig. 1, or rotary, as in Fig. 2.

It must be stated that if the ring is given the two positions shown in the two cuts, the glass is altogether out of the scope of the eye-piece and then this latter works as usual.

If on the other hand the ring is brought back against the hollowed bottom of the cup, the glass will completely mask the objective.

If the faces of this glass were plane and par-

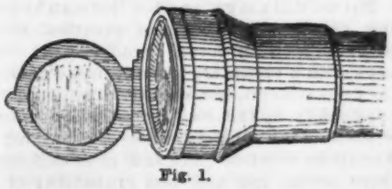


Fig. 1.

allel, the visual ray would follow the very same line, whether the apparatus were closed, or open but, although these faces are plane, they are oblique one on another, so that the glass presents the form of a wedge, the sharp edge being downwards.

The visual ray as it traverses this wedge is refracted vertically, or, in other words, turned away from its initial direction, according to an angle that depends on that of the faces of the glass and the refraction indicator of the matter comprising it.

Consequently, if the eye piece is directed

Fig. 2.

against a levelling staff read by the instrument and that the apparatus is open so as to leave the scope of the eye piece, the horizontal thread of the hair-cross will be projected on a certain division of the staff. Then, if the apparatus is closed without moving either the staff or eye piece, the horizontal thread will be projected by refraction on another division of the staff.

The angle of refraction being a constant, independent of the distance from the levelling staff to the instrument, it follows that the difference of the readings made on the staff will be proportional to the distance of that staff, and hence the possibility of ascertaining that distance.

For this purpose the glass may be made so that the angle of refraction may give a difference of one centimetre, for instance, for every metre of distance. The operator may, it seems, regulate the instrument without requiring to measure a base.

The *Annales* points out that after the first readings on the staff, it is a very delicate operation to shut the apparatus without in some measure disturbing the eye piece. With this condition fulfilled the theodolite will become transformed into a planimetric instrument suitable for the immediate calculation of distances.

MARQUETTE, HOUGHTON & ONTONAGON R. R.—No work has been done yet on the Ontonagon extension, and the time for completion is July 4th. The unearned portion of the land grant will probably be forfeited.

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WE wish to buy all the copies of ENGINEERING NEWS of March 27th and April 3rd, 1886, that are offered, and will pay 12 cents in cash, for each copy received, or will send the "Engineers' Field Book" for the two.

THE Bruns' bill was defeated at Albany on the 12th.

THE New York Arcade R. R. bill has been signed by the Governor. The Arcade Company say they will begin work in sixty days. The prospect for a long and expensive fight with the N. Y. District R. R. Co. is, however, very fair. The offices of the N. Y. Arcade R. R. Co. are in the Boreel Building, 115 Broadway, and there is already a large procession of people with various axes to grind passing through the Company's office.

BY an extra issue of new $4,000,000 stock, (making its total capital $96,000,000) the Pennsylvania Central R. R. Co. propose to provide the necessary capital for construction and equipment expenditures during the year 1886 on the main and leased lines and branches, and for the completion and extension of new and auxiliary lines, the cost of which is estimated as follows: Construction work, Pennsylvania Railroad, branches and leased lines, $600,000; real estate, Pennsylvania Railroad, branches and leased lines, $400,000; locomotive engines, passenger equipment, etc., $800,000; new construction on branch and auxiliary lines now in operation, $700,000, and for new branch and auxiliary lines under construction, $1,500,000.

THE comparative safety of European railway compartment coaches and the long open American ones is again brought vividly to mind by a cablegram in the New York *Tribune* of last Sunday, relating to the trial of a man charged with robberies in French railway carriages while the trains were in motion and then, by virtue of dexterity acquired while formerly acting as a ticket collector on railway trains, managing to jump from the train and escape. The man was convicted of two robberies, and was then put on trial for committing a murder in a railway carriage, throwing the body off, and, following it himself, conveyed it to a pool near by in which it was afterwards found.

Americans traveling alone in France cannot be too careful about venturing into compartments on the railway trains. The risk of robbery or assault is very much less on English railways, and it is always possible to secure the undivided monopoly of a compartment by a judicious friendship with the conductor.

SENATOR HOAR, of Massachusetts, has introduced a resolution bearing on the River and Harbor bill, which, if accepted by the Senate, will lead to the suppression of the abuses that have grown out of Secretary Gallatin's famous report advising in fact that the money for internal improvements should be divided with reference to the wishes of sections rather than to the results obtained by the expenditure.

Senator Hoar's resolution directs the Committee on Commerce to report with each item of the River and Harbor bill, the facts which render the proposed appropriation advisable, its national importance and the present condition of the work if commenced. Although about ninety-six per cent. of the money expended for internal improvements has been for objects of national benefit some appropriations for useless streams or harbors have been made, to the discredit of the useful ones. The discussion that would follow the adoption of the Senator's resolution would check even the presentation of ill considered or strictly sectional schemes.

GOV. HILL signed the New Aqueduct Bill on the 13th and named the new Commissioners. They are Hamilton Fish, Jr.; Edgar L. Ridgway; and Oliver W. Barnes, the last named being the well known Civil Engineer, late Chief Engineer of the South Pennsylvania R. R. The salary of each Commissioner is $5,000, instead of $8,000 as heretofore.

THE Anarchist and Socialistic elements are already very thoroughly subdued. This does not appear to be a country where that sort of "liberty" is tolerated, and now with all the chiefs of the party, except Parsons, in prison with a good prospect of their being kept there for some time to come, their principles will soon be harmless for mischief. The labor troubles are subsiding; many compromises have been effected; many strikers have returned to work, and it is probable that another month will see a much easier state of affairs.

ONE of the severest and most disastrous storms of wind and rain that have been experienced in many years prevailed in many portions of the country this week. Its effects have been most damaging to property and fatal to life in Kansas City and at Xenia, O., while throughout the states of Pennsylvania, Ohio, Indiana and Illinois it has caused a vast destruction of property in the shape of washed out bridges, culverts, and railroad embankments, damaged sewers, flooded highways, wrecked buildings and other forms, causing great distress and suffering among the inhabitants of the afflicted regions.

The Gun Question.

Mr. Wm. Metcalf, M. Am. Soc. C. E. and one of the proprietors of the Crescent Steel Works of Pittsburg has written a letter to the *Army and Navy Journal* urging substantially the same views as advocated by Captain O. E. Michaelis in his paper on this same subject, read at the Buffalo meeting of the American Society of Civil Engineers.

A long and successful experience in making the better kinds of steel and his early connection with the Rodman Gun Foundry at Pittsburg, when our Rodman guns dominated the artillery of the world, give to Mr. Metcalf's views a decidedly practical value, and his conclusions are strongly for a cast-steel annealed gun, cast on the Rodman plan, *i.e.*, internally cooled, deciding first that the form adopted by Rodman with the necessary modifications in its curves in consequence of its greater length is nearly if not quite perfect and pronouncing for cast-steel as the proper material, he considers the various modes of preparation; viz., forging, liquid compression, and annealing. These are all different modes of producing a uniform crystallization in which the crystals are of the smallest attainable size, or in other terms producing the strongest steel.

In forging, this is accomplished by heating the steel and compacting it by heavy and rapid blows from a hammer, thus increasing its density and forcing the formation of small crystals. Successful practice in this direction is so limited by the size of the object forged that it is necessary to build a gun of many pieces which Mr. Metcalf considers "an unmechanical, unscientific agglomeration of uncertain strength."

The method by liquid compression which is largely employed in England, is objected to on account of the great cost and its uncertain results, as, if the first operation is unsuccessful from any cause the whole work is lost.

Annealing, which is necessarily resorted to in the case of steel castings, is not obnoxious to any of the above charges; for, if the first annealing should not be complete the operation can be repeated as often as necessary until the desired result is obtained. It is a property of cast-steel well-known to steelmakers, that an ingot can be made as fine in the grain, more homogeneous and free from internal strains and quite as strong by annealing as it can be made by any amount of hammering or rolling."

The letter concludes, after stating that it has cost Europe many millions of dollars to secure a feeling of safety, which is not authorized against those old Rodman guns, "What America needs is another Rodman to develop his principles again, and so place our armament away in advance of anything that has been done anywhere in the world," a sentiment with which every American not having an agency for a foreign gun factory will heartily agree.

But we will not get another Rodman by sending young officers without practical knowledge to visit European foundries and come back with a pecuniary interest in the methods they recommend, nor can a Rodman be developed solely by the study of what oth rs have written on the subject, and as the training at Annapolis becomes more and more scholastic there seems less and less probability of its graduates becoming contributors to the advance of their country by means of any inventions of theirs looking to the improvement or material cheapening of production.

This view of the question, among others, has led us to urge on Congress and the public the superior advantage that would accrue to the country from demanding guns of certain

size and strength from our manufacturers rather than from establishing costly government factories to be presided over by the Turveydrops and Pecksniffs of war and manufacturing, who seem, through the aid of either political or social influence to generally capture such positions.

The Practical Results of Two Inventions.

When Henry Bessemer was studying and experimenting over the problem of steel making direct from the ore, it is hardly to be supposed that he had any idea of the political significance of the success of his invention. But the change from iron to steel track on our great trunk railways, so cheapened transportation that the unlimited food products of our western prairies could be offered for sale at such low prices in English free trade markets, as to beat home products, and thus disturb the hitherto comfortable relations between the great patrician land owners, and their tenantry. Farming became unprofitable; rents had to come down, landed estates were not the objects of the reverence of the past; more young English farmers preferred to go to the broad prairies, from whence came the ever-growing volume of meat and grain, rather than pay high rents at home, with the prospect of constantly declining markets, and so while democratic America was benefited, aristocratic Britain was badily injured in the hitherto most invulnerable part of its body politic. With the extension of railways in the West, more land was cultivated to supply the export demand, towns and villages were built, and great, thinly settled territories were transformed, in a decade or two, into more or less thickly populated states with all the political significance which they imply. We cannot yet measure the far reaching industrial and political results of this one invention of an observant and persevering investigator.

A more recent invention presents also some interesting results. In our boyhood we were very familiar with the differences between fall (or winter) wheat and spring wheat: their dissimilarity of color and size and hardness; their inequality in price, and their relative merits in the form of bread. Whoever could afford to buy winter wheat flour never spent any money on the other, which produced only "sticky" and dark colored bread. But gradually the winter wheat was displaced with an unobjectionable product of spring wheat and finally the latter obtained full possession. The day of "sticky" bread in well ordered households had passed away forever and a cheaper and a better substitute reigned supreme. This is an experience familiar to many of our readers, who yet, like ourselves, have been so unfamiliar with the progress of invention that they would not be able to associate the change above indicated with the investigations of a French scientist regarding the movements of the dust atoms in his study. But in the *Century Magazine* for May there is a very interesting illustrated article on the "Flour Mills of Minneapolis," in which the evolution of the low-grade spring wheat into "number one hard" in a very few years by reason of ingenious inventive processes is given in the always charming style of Mr. E. V. Smalley, the well known magazine writer.

From Mr. Smalley's account it appears that in 1860, a French *savant*, Joseph Perrigault by name, began investigating the movements of atoms floating in the air of a room. He observed that these molecules described light curves of a nearly horizontal figure: that, to quote the language of Perrigault himself—"They slowly sank, but they sank; and when they arrived at one or two millimetres only, I saw them throw themselves on the surface of the table, obeying evidently a law of attraction, the causes of which have never been explained." This explained the presence of dust in every open pigeon-hole of a desk or on the shelves of a library. The atoms, moving horizontally, do not fall until they are close to the surface of a solid body, It makes no difference how high the shelf is, or how small the pigeon hole, the exposed surface collects a quantity of dust proportionate to the quantity of atoms which come within the sphere of its attraction.

What was called the "new-process" milling had already been invented and put into practical use in Hungary and from there brought to America in 1876. In spite, however, of all the benefits of this process, the adhesion of some dust to the "middlings" of the wheat in its conversion into flour, still kept this flour at low grade on account of inferior quality. The discovery of Perrigault and his application of it to milling purposes by inventing the "middlings purifier" at once revolutionized milling. We give the results in Mr. Smalley's graphic language.

"The invention was brought to this country by Ex-Governor C. C. Washburn of Wisconsin, in 1871, and put in one of his mills at Minneapolis, where it was still further improved by two practical American millers. The middlings purifying machine, and the process of gradual reduction milling of which it forms a part have built up the beautiful city of Minneapolis, and sent a million of people out on the prairies of Minnesota and Dakota. * * * With the enormous difference of thirty cents a bushel against them, farmers in Minnesota were at a serious disadvantage in comparison with those of the winter wheat belt. The settlement of the fertile prairies of Northern and Western Minnesota progressed very slowly. Nobody tried to raise wheat in the rich valley of the Red river of the North. Immigration poured into Kansas, but could not be coaxed into Dakota. All this was changed by the middlings purifier, and the new process of gradual reduction milling. The spring wheat known as "number one hard" became the most valuable of any for the making of flour. The conditions of farming in the Northwest were immediately changed. The great natural product of the region came into brisk demand. From the hard wheat of the northwestern prairies a flour was made by the mills of Minneapolis which commanded a higher price in New York than St. Louis winter wheat flour, until then the favorite among western brands. Population poured into Minnesota and Dakota, railroads were built, towns sprang up as if by magic, and the bare plains were turned into wheat fields. * * * What a wonderful result from a Frenchman's studies of dust particles floating in the atmosphere, and settling in the pigeon-holes of a writing-desk!"

PERSONAL.

H. J. Stanley has been elected Chief Engineer of the Cincinnati Board of Public Works, to succeed Mr. Danenhower.

F. L. Hills was elected Chief Engineer of the Wilmington & Northern R. R. at the recent meeting of that company.

Stevenson Towle, Mem. A. Soc. C. E., late Chief Engineer of Sewers of this city, has removed his office to 115 Broadway.

Mr. A. M. Brown, President of the Pittsburg Bridge Co., has been elected Vice-President of the Keystone Bridge Co., of that city, Vice-Manager Jones, resigned.

F. D. Childs, for many years Superintendent of the Hinckley Locomotive Works in Boston, has accepted a similar position in the Canadian Locomotive Engine Cos' Works, Kingston, Canada.

Nathan Walker Horton, Superintendent of the Rand Drill Co. and Secretary of the Rend Rock Powder Co., while superintending the shipment of some material at the Company's works at Tarrytown, on the 6th, was accidentally dragged under one of the wheels of a freight car and had his leg so terribly injured as to cause his death the next day. Capt. Horton served with the Ninth Pennsylvania Cavalry during the war and was a member of the Loyal Legion at the time of his death. He was connected with the Rand Drill Company, in which he had an interest, for thirteen years, and conducted the business of that firm with great ability. His genial disposition, was well-known, and made for him a large circle of friends, who, with his bereaved widow and family, mourn his untimely end. The following is from *Harper's Weekly*:

There died last week in this city, at the age of forty-four, a business man whose last hours displayed a fortitude and a tenderness that literature might preserve. While superintending the removal of some machinery he was thrown under the wheels of a freight car, and had the flesh almost entirely stripped from one of his legs. While waiting for a surgeon he continued to give his orders to his men, and wrote a telegraphic message to his wife to meet him on the arrival of a certain train. "I have met with an accident," it read, "but I write this with my own hand." On arriving at the Grand Central Depot he was borne on a stretcher through the waiting-room. As soon as he saw his wife in the crowd he waved his hand to reassure her, saying, gayly, with a smile, "Here I am Annie." When told that the limb must be amputated, "All right," he replied; "only leave enough for me to ride horseback with." The announcement, a few hours later, that he would not survive the operation was received with perfect calmness. "It's odd," he observed, dryly, "that after dodging bullets for four years in the war, and after facing danger for twelve years in and around mines, I should at last be killed by a freight car." The next morning he was dead, having retained his consciousness and calmness to the end.

Missouri Association of Surveyors and Civil Engineers.

Sixth Annual Meeting, beginning on Thursday, June 3, 1886, in Engineering Rooms of Missouri University at Columbia, Mo. The following is the programme for the meeting:

"Surveyors of Mines," by J. E. Garrett; "The Legal Position occupied by a Surveyor in State of Missouri," by C. D. Rodgers; "Descriptions in Deeds," by W. L. Combs; "Transportation by Railroads," by Geo. C. Pratt; "The Water-Works of Moberly, Mo.," by A. J. Swetnam; "Decisions of Missouri Supreme Court on Boundaries and Corners, Plats and Street Grades," by J. Y. Powell; "Decisions of Missouri Supreme Court on Drainage and Riparian Rights," by S. J. Carter; "Wagon Roads," by Van Court Yantis; "Sewers for Towns," by Chas. H. Zoll; "Road Paving Materials," by G. W. Latimer; "Hydraulics," by J. A. Seddon; "St. L. & K. C. Air Line R. R.," "Drainage Laws of State of Missouri," by M. G. Quinn; "Electric Motors," by W. L. Seddon; "Drainage Engineering," by Ezra D. Shreve; "Pure Water and Pure Air," by Paul Schweitzer; "The Surveyor and his Field Notes," by Geo. H Roberts; "Suggestions to Beginners in Land Surveying," by T. H. Halley; "Solar Compass in Land Surveys," by T. C. Thomas; "Graphic Method of Determining Maximum Moments,' by W. H. Schuermann.

Surveyors and Engineers will please inform T. J. Lowry or W. E. Wright, Columbia, Boone county, Mo., if they will attend this meeting. This information is desired at once so that arrangements may be perfected for securing reduced railroad fares for them. All Surveyors, Ex-Surveyors, Civil Engineers and Bridge Builders are cordially invited to attend. Instrument manufacturers are requested to attend and exhibit their instruments

In addition to the above programme, there will, it is hoped, be other papers (on surveying, engineering and kindred subjects) contributed by members of the Association.

T. J. Lowry, *Sec'y* Geo. C. Pratt.

A New Orleans paper of the 13th, says that the Panama Canal Co. have received one-third of the $120,000,000 loan asked for.

Friends of the Panama Canal scheme say that M. de Lesseps is "moving heaven and earth to complete the job." "M. de Lesseps," observes the San Francisco *Wasp*, "would get on faster if he would move less heaven and more earth."

The Lockport Water Supply Company, recently incorporated by an act of the Legislature, has elected John Hodge president. It proposes to cut a hydraulic race from the Niagara river, a distance of 20 miles, to the head of a ravine, cutting through the mountain ridge close to Lockport, and then running through a natural water course to Lake Ontario. The route is the one originally surveyed by the government for a ship canal. Reliable estimates of engineers give 80,000 horse power, at a cost of a little over $3,000,000.

Sand as a Foundation.

Compiled for ENGINEERING NEWS.

BY W. W. CURTIS, C. E.

The incompressibility of sand renders it an excellent foundation for structures, whenever it can be protected from wash; and this property, which it possesses to such a great degree, has led to its occasional use in compacting more compressible soils.

Of the existence of any detail notes, however, in the English language, upon the subject of the peculiar action of sand; the law of its distribution of pressure when enclosed; its reliability when used artificially, and of the results of practical applications, the writer is unaware. A somewhat careful search has failed to discover any except a short note in the Papers of the Corps of Royal Engineers, 1840.

In the French periodicals there have been several articles, a résumé of which was given in the *Annales des Ponts et Chaussées*, from which the material for the following notes has been derived. These papers in detail are as follows:

Notice of a new method of founding in bad soils; by

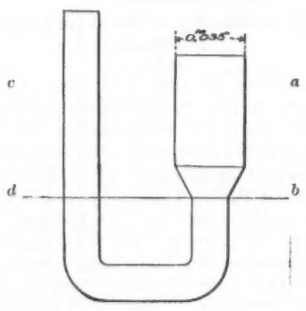


FIG. 1.

M. Moreau, Captain of Engineers, published in "Mémorial du Genie," 1832;

Memoir on the employment of sand in foundations in bad soils; M. Niel, Captain of Engineers, *idem*, 1836;

Notice of experiments with sand made at Geneva, by M. Huber-Buraand, in the Bibliothéque Universelle de Genève, 1829;

Note on various foundations in sand, executed in Paris; M. Mary, Chief Engineer of the Ponts et Chaussées;

Note on foundations of sand; M. Devilliers, Division Inspector, Ponts et Chaussées.

There is no claim to originality with the writer in what follows: it is proposed simply to present in logical order, the data of the writers mentioned above, with some conclusions thereupon.

Any apology needed for reproducing the material of these articles, must be found in the absence of anything similar in our literature upon a subject of such great practical importance. It is to be hoped that others may become interested and continue the investigations, giving us further facts and the discussions of them: as well as that some may be induced to avail themselves, in their practice, of the positive knowledge which we already have; for it certainly seems that with an intelligent application of the following principles, we can save time and money in many cases, as well as obtain greater security from dangerous settlements, by the use of sand, than is possible with either concrete or piling at any permissible expense. From the results of experiments conducted at Geneva, the following statements may be made:—

1. If in the sides or bottom of a box filled with sand, a hole is made, the sand issues with the same velocity whatever may be the height of the sand above; and if the hole is pierced horizontally, and with a diameter somewhat less than the thickness of the sides of the box, no sand will pass through.

2. Any pressure which may be imposed upon the surface of the sand, has no effect upon its rapidity of exit through a given orifice. These facts were deduced from experiment with a box 0.3 m. (12") square and 0.8 m. (31") high, and with a tube inserted in it of 0.1 m. (4") diameter, and 1.2 m. (47") length; the amount of sand used being successively 12 and 25 kilograms (26 and 55 lbs.)

3. Sand when poured into one end of a U shaped tube having square elbows, as represented in Fig. 1, will not extend into the other side, and will reach but a short distance in the horizontal portion.

4. Sand will never assume a level surface of itself, having usually an inclination with the horizon of from thirty to thirty-three degrees.

5. In a pile of sand well settled, the lower layers inclined at an angle of thirty degrees support naturally the upper ones; but the greater part of the weight of the latter is taken by that part of the horizontal plane, upon which they abut. If a portion of this horizontal plane is removed, the entire layer of sand which had abutted upon it, slips down, leaving the lower layers exposed, inclining at their angle of repose, thirty or thirty-three degrees.

This explains why the sand does not run through an horizontal aperture which has more depth than width, for in such a case, the layers above the base of the aperture find points of support upon its sides, and are upheld also by the beds beneath.

6. If mercury is poured into the branch *a b*, Fig. 1, it takes the same elevation in *c d*. If the cup *a* is then filled with sand, the level of the mercury is but very little affected. In performing this experiment with the tube represented in the figure, of which the largest diameter was 0.035 m. (1.38"), the change of level was 0.002 m. ($\frac{5}{64}$"); and the experimenter attributed this to the oscillations of the mercury incident to manipulation. This result was verified by numerous repetitions, one of them being with a tube of 4 inches diameter. It was attempted, without success, to force out the sand, either when the tube was horizontal or inclined at an angle of twenty degrees with the horizon, and when the effort was sufficient to break it.

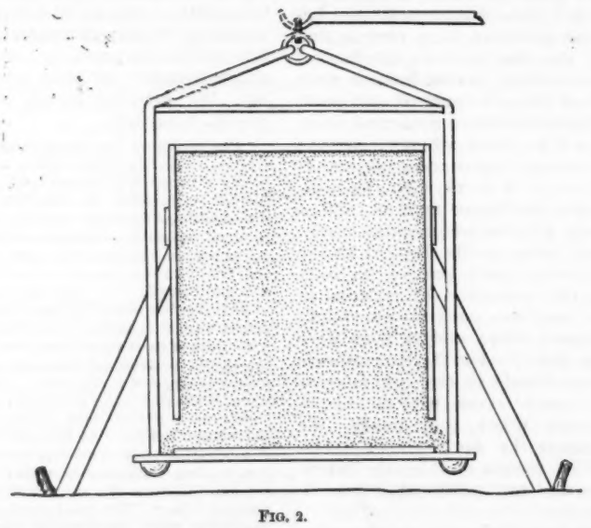


FIG. 2.

Experiments made at Bayonne in a miry soil of great depth, upon which it was desired to erect an arsenal, and where the use of timber piles was forbidden by the variation in the height of the ground water, due to the tides of the sea:

7. After consolidating the soil by means of a rammer weighing 50 kilograms (110 lbs.), handled by four men, a thin layer of sand was spread upon it, and then a pier of squared stone was built, the bottom course of which was 1.2 m (3.94') square. Upon this pier a load of 30,000 kilograms was placed, (nearly 30 lbs. per square inch); settlement was rapid, after 8 days amounting to $2\frac{13}{16}$".

		METRES.	INCHES.
Under 480 kilograms (1058 lbs.) settlement was		0.001 =	0.04
" 960 " (2116 lbs.) " "		0.002 =	0.08
" 1440 " (3174 lbs.) " "		0.003 =	0.12

24 hours later this was increased by 0.004m. = 0.16".
Under 18000 kilograms (39683 lbs.) it was 0.005m. = 0.20".

After two days more, no further movement having taken place, the load was increased to 21,000 kilograms (46287 lbs.) without any effect; then to 30,000 kilograms (66139 lbs.) which increased the settlement ½ millimetre ($\frac{1}{64}$").

The movement under this last load, equivalent to about 13 pounds per square inch, continued slowly, the entire settlement a month later having become 0.016m. ($\frac{5}{8}$").

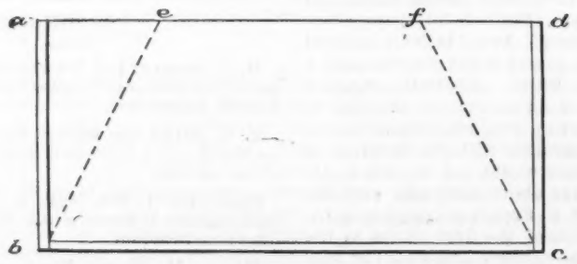


FIG. 3.

8. Nine piles 0.22 m. (8¾") in diameter and 1.3m (4.26') long were driven distant 0.4m. (1.31") center to center. They were hammered until they sank no more than 0.07 m. to 0.08m. (2¾" to 3") under a volley of 15 blows of a ram weighing 100 kilograms (220 lbs), falling 1.m. (3.28'). This would be about ¼ centimetre ($\frac{1}{10}$") per blow.

A load of 18,000 pounds was then applied, with a consequent settlement of 0.005m. ($\frac{3}{16}$).

These two experiments illustrate the superiority of piles over simple percussion, as a means of consolidating the soil. If we regard the compression to extend 0.1m. (4") beyond the exterior line of piles, the volume acted upon would be 1.5 c. m. (52.9 c.f.) and as the volume of the piles was 0.3 c. m. (10.6 c.f.), the decrease would be one fifth. To have produced this effect by percussion of the surface, it would have been necessary to depress the top layers 0.24m. (9½") which was beyond the capacity of the ram.

In the case of impact upon earth, the immediate layers are compressed at once, and then act by their inertia and adhesion to the surrounding soil to intercept the effect of the blow and thus prevent the consolidation of the lower strata, which the piles would reach, and which it is necessary to consider, as the heavy masses of masonry, acting slowly but continuously, make themselves felt at these points, with resulting settlement.

9. These nine piles were then withdrawn and the holes filled with a very friable stone reduced to a powder, and consolidated with a rammer weighing 10 kilograms (22 lbs.). Sixteen more holes were similarly treated, thus increasing their number to 25, enclosed in a square 1.82m. (5.97') on a side. There was no perceptible swelling of the soil between the piles.

After leveling and pounding the surface with a rammer handled by four men, a pier of masonry was built upon the site, and loaded, with results as follows:

10. A pit having been sunk to test the soil, it was found to consist of mud and clay. After a layer of 0.4m. (16") thickness was removed, a loose material was found, into which a rammer would sink 0.15m (6") at each blow. To consolidate this ground twenty five piles, 1.3m. to 1.6m. (4¼' to 5¼') in length, were driven, the pounding being continued until they sank only 0.1m. to 0.11m. (about 4") under a volley of twenty blows of a hammer weighing 100 kilograms (220 lbs.) falling 1.0m.(3.28'). The ground between the piles very soon commenced to swell up, reaching in the center of the

square in which the piles were driven, a height of 0.4m. (15¾"). After sawing off the piles to a uniform elevation and leveling the earth between, the loading was applied.

Under 13,000 k. (26455 lbs.) settlement was 0.001¾m. = $\frac{1}{16}$.
" 18,000 " (36983 lbs.) " " 0.002m. = $\frac{3}{16}$"

3 days later when the loads were removed the settlement had become 0.005m. ($\frac{2}{16}$").

11. Thirteen of the piles of the tenth experiment were withdrawn and the voids filled with sand of the same quality as used in the ninth experiment; on the following day the twelve remaining ones were treated in a similar manner, it being noted that more force was requisite to withdraw those of the last lot.

To calculate the amount of compression effected in the original volume of the foundation, it is assumed that as the swelling did not extend beyond the limits of the line of piles, the compression is confined within the same bounds, and hence the volume acted upon is equal to 4.3 c.m. (151.85 c. f.). Making a deduction of the material displaced by the masonry—built upon the site, and the bed of which was a little below the surface—equal to 0.77 c.m. (27.19 c. f.), from the volume of

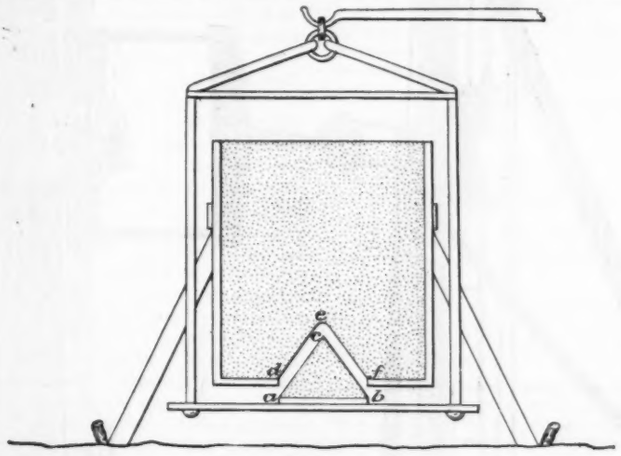


FIG. 4.

the twenty-five piles, which was 1.233 c.m. (43.53 c. f.), the amount of compression was 0.463 c.m. (16.34 c. f.), or about one-ninth.

When the weight of the masonry reached 2,400 kilograms (5,291 lbs.), there was rapid settlement, supposed to be due to the compression of the first layers of mortar and of the soil at the immediate surface. Within six hours after commencement of masonry there was 15,000 kilograms of lead placed upon it, causing a settlement of 0.005 m. This was increased to 29,200 kilograms (64,374 lbs.), with a settlement of 0.0105 m. (0.41").

The observations of the effect of this load were continued for seven months, the movement being slow and the total increase of settlement, 0.007½ (0.29"), distributed as follows:

1st	month after application of load	0.004$\frac{1}{16}$ m.
2d	" " " " "	0.001$\frac{1}{16}$ "
3d	" " " " "	0.000$\frac{7}{16}$ "
4th	" " " " "	0.001 "
5th, 6th & 7th	" " " " "	0.001 "
Total		0.007$\frac{1}{16}$ m.

being a little less than 0.001 m. ($\frac{1}{16}$") per month.

The load was then reduced to 10,500 kilograms (23,148 lbs.), and eighteen months later had produced no further settlement.

The fact mentioned above, of the greater effort required to withdraw the last half of the piles, when the others had been replaced by sand, indicates a difference in the action of wood and sand piles; and bearing in mind the results of the Geneva experiments, it is not difficult to understand the fact. When a wooden pile is driven, it compresses the soil in exact proportion to its volume, and this consolidation is retained temporarily when it is withdrawn: if the hole is immediately filled with sand, the entire effect is retained, and by ramming the sand, is increased in proportion to the weight and ability of the latter to transmit pressure laterally. The interstices of the sand, moreover, act as so many small wells into which the moisture of the adjoining earth drains, although in this case no water was found in the hole when a pile was withdrawn.

Experiments with sand in a chest having the entire bottom detached.

12. A box 0.7 m. long, 0.6 m. broad and 0.7 m. deep (2.3' × 2' × 2.3'), of which the bottom (Fig. 2) was detached from the sides but left in place, was placed upon the platform of a balance and filled with damp quartz sand of medium size. The weight of the sand was 468 kilograms (1,031 lbs.). The box was then supported by side braces so that the weight of the sand was transmitted to the platform of the scale entirely through the medium of the bottom. The weights which had been required for equilibrium on the other platform were then taken off, little by little, resulting in a gradual sinking of the bottom of the box and the sand sustained upon it. When the scale weights were reduced to 256¾ kilograms (565 lbs.) the bottom was carried away by the sand, which slipped along the sides of the box.

This experiment was repeated with a load upon the sand of 258 kilograms (569 lbs.), making the entire weight 726 kilograms (1,600 lbs.), when the bottom

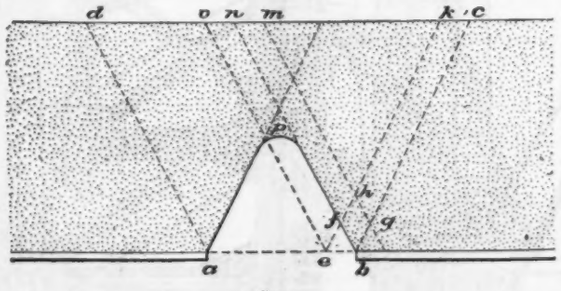


FIG. 5,

separated from the box with 400 kilograms (881 lbs) in the scale pan.

With a surcharge of 508 kilograms (1,120 lbs.), making a total weight of 976 kilograms (2 151 lbs.), the bottom separated with 500 kilograms(1,102 lbs.) in scale pan.

Taking the ratio existing between the weight of the sand and load, and the weight in the scale pan at the time of failure or separation of the platform and bottom from the box, there results,

$$\frac{468}{256.5} = 1.82 \qquad \frac{726}{400} = 1.82 \qquad \frac{976}{500} = 1.95$$

The pressure upon the bottom, we can then conclude, is sensibly proportional to the amount of surcharge.

The same experiments were made, replacing the sand with vegetable soil, with these results:

$$\frac{398.5}{235} = 1.68 \qquad \frac{638.5}{320} = 1.99 \qquad \frac{900.5}{405} = 2.22$$

Here the relation is more variable, due to the modification of the adhesion to and friction against the sides, from the compression of the material caused by the added weights. At the end of the last experiment with the vegetable soil, the earth had become very much more compact than in the first one; while in the case of the sand there was no appreciable change.

It was observed that when the bottom of the box was in its original position the pressure of the sand upon the sides of the box did not decrease the vertical pressure upon the bottom, which was equal to the weight of the sand itself; the prism of greatest thrust weighs none the less because it tends to push out the vertical sides which contain it.

After the bottom moves, however, friction is developed between the sides and the filling, and the sides are pressed vertically the amount of which the bottom is relieved. To render this more apparent suppose the box *abcd* (Fig. 3.) filled with sand; let Q be the weight of the sand, F the horizontal pressure that the prism of greatest thrust *a b c* exerts upon the side *ab*; the friction being proportional to the pressure, and m being its co-officient, its value will be mF; if n is the co-efficient of adhesion, the resistance which it opposes to the movement, being proportional to the surface, will be nh, if h represents the height *ab*. To simplify the problem and to bring its conditions as nearly as possible to those of the foundation of a wall, consider only the resistances opposed to the movement by the sides *ab* and *cd*; that is, suppose the box to have an indefinite extent perpendicular to the plane of the paper.

In the condition of repose the bottom *bc* will be pressed by the weight Q, but if it commences to yield the pressure is no longer Q, but

$$P = Q - (2\,mF + 2\,nh)$$

and it will be necessary to provide resistance equal to $2\,mF + 2\,nh$ to support the increase of weight upon the sides *ab* and *cd*.

If the distance between the two sides is decreased, the force Q also decreases as the quantity of sand contained becomes less, while the term $2\,mF + 2\,nh$ remains constant as long as the width of the box does not become less than 2 *ae*. At the moment when this limit is passed the term $2\,mF$ commences to diminish, but with less rapidity than Q, and the term $2\,nh$ remains constant throughout.

It becomes evident thus, how much the diminution in width affects the pressure upon the movable bottom, and it is not surprising that, in the case of a small tube, it requires but a few grammes to secure equilibrium in the pressures.

Experiments with sand in a chest, part of the bottom of which was detached.—Having ascertained the law controlling the pressure when the entire bottom of the box is movable, it becomes desirable to study the effect on the distribution of the weight when only part of the bottom is disconnected.

Experiments for this purpose were made by two parties independently, with apparently somewhat discrepant results.

The first of these, made by Capt. Moreau were as follows:

13. A box 4 m. long, 1 m. wide and 1 m. deep (13' × 3¼' × 3¼'), in the bottom of which were openings successively of 0.27 m. (10½") and 0.60 m. (23½") breadth, which were closed by a rectangular wooden valve 2.22 m. long, one end hinged and the other supported by a cord passing over a pulley and attached to a scale pan, was filled with damp fine river sand and surcharged with weights running up to 4,370 kilograms per sq. metre, (880 lbs. per sq. ft.)

14. To find the pressure of *dry* sand, a smaller box 0.6 m. long, 0.5 m. wide and 1 m. high (2' × 1.6' × 3¼") was used.

It was found, the length and height of the mass of sand remaining the same, before the valve closing the aperture moved, the pressure upon a definite part of it, as indicated by the weights required in the scale pan for equilibrium, varied with the amount of surcharge; but if the valve yielded, the pressures became uniform whatever the loading.

The second series of experiments, conducted by Capt. Niel were as follows:

15. A box 0.6 m. long, 0.5 m. wide and 0.6 m. deep (2' × 1.6' × 2') was used, the bottom of which was solidly fastened to the sides, except the piece *a b* (Fig. 4), which was detached, and which rested upon the platform of the balance. The length of the opening *d f* was in each case equal to the width of the box 0.5 m., while the width varied. It was found, as when the entire bottom was movable, that the pressure exerted upon the part *a b* decreased in amount as it separated from the box; moreover a prism *a b c* was detached suddenly and a pointed arch *d e f* became visible from below, which seemed to support the entire mass above.

At first the opening was 0.2 m. (7¾") in width; then it was increased by degrees up to 0.35 m. (13¾") with the same results; when this limit was reached, however the least concussion made the arch fall in, and the entire prism of sand run out, leaving the slope always steeper than forty-five degrees.

This experiment was repeated loading the sand with 200 kilograms (440 lbs.), without any variation in the result; and in one case the arch having been formed without any surcharge, a weight of 200 kilograms was

placed upon the sand, apparently with the effect of increasing the stability of the arch.

This formation of an arch is explained by the inability of the sand to assume for itself a horizontal position, and its property of always taking a given slope.

Let us suppose that the lines $a\,d$ and $b\,c$ (Fig 5) give the inclination at which the sand would maintain itself alone; cohesion and friction following the lines $a\,d$ and $b\,e$ combine to hinder the fall of the prism $a\,b\,c\,d$ but this restraining force is not equal at all points of the prism.

(TO BE CONTINUED.)

Twenty-ton Block-setting "Hercules" at Mandavee, India.

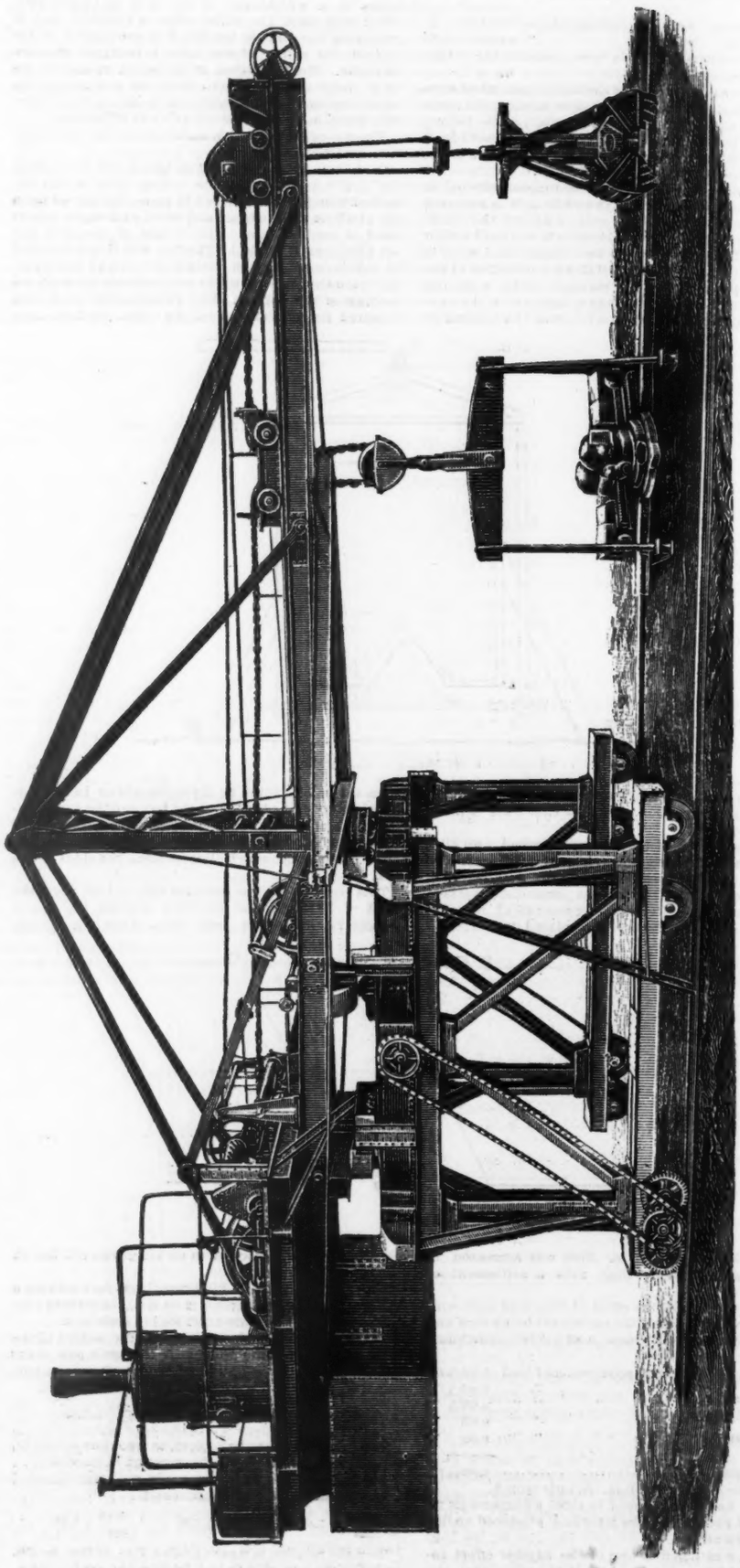
The accompanying illustration (reproduced from *Engineering*) represents a machine built for the special purpose of handling blocks of concrete up to 20 tons weight used in the pier construction at Mandavee, India.

This pier is composed of rows of concrete cylinders 10 feet 6 inches in diameter, placed side by side; each cylinder being built up of separate rings placed one on the other; the interior of the cylinders is dredged out by a grab to enable the cylinders to penetrate the bottom to a sufficient depth, and they are afterwards filled with rough concrete.

The general design of the setting machine will be seen from the engraving. It consists of a truck on which revolves a horizontal jib along which the load can be run to the required position previous to being deposited in place. The truck is carried by eight wheels, which run on a 14 foot gauge railway laid along the completed portion of the pier. The truck is made high enough to allow the trollies carrying the concrete rings to pass completely underneath it, so that the rings can be lifted off by the travelling jenny and run out. Across the top of the truck is placed a framework of girders, which support the center pivot and also the roller paths on which the superstructure revolves.

The superstructure consists of a braced frame carrying a horizontal jib, the total length of this jib from back to front being 65 feet 9 inches. It consists of two main girders, which carry the jenny rails in front and are splayed out at the back end to form a platform for the engines and gearing. The main travelling jenny has a range of 21 feet, 6 inches clear of the front of the truck, which corresponds to a radius of 33 feet 6 inches from the revolving center.

The motive power is derived from a vertical boiler, which supplies steam to two engines with cylinders 8 inches in diameter by 10-inch stroke. These actuate the following motions: Lifting gear, two speeds; racking motion, two speeds; slewing motion; traveling motion for propelling the whole machine along the rails and a lifting gear for the grab. At the back of the machine is placed a large tank into which is put the requisite amount of sea water to balance the Hercules when the load is run to the extreme radius.



TWENTY-TON BLOCK-SETTING "HERCULES" AT MANDAVEE, INDIA.

SYRACUSE, N. Y.—At a recent meeting of the Syracuse Water Company resolutions were adopted stating the readiness of the company to give the city the best attainable water supply, and its willingness to meet the public demand. A committee consisting of the President, A. C. Belden, Wm. B. Smith, A. A. Howlett and A. H. Davis was appointed to confer with the Mayor and Common Council. The subject of procuring water from Salmon river was discussed, and the President was by unanimous vote directed to investigate the availability of the river as a source of supply.

A huge enterprise is on foot in the northern part of Aurora county, Ill., for the purpose of draining the large swamps at the head of the Kishwaukee creek, which is drained by Rock river. By digging a ditch seven miles long, eight feet deep and forty feet wide, at an expense of $15,000, it is expected to drain 5,000 acres of land which is now utterly useless.

Coal in China.

The extent and value of the coal seams recently discovered in Chinese territory are matters of great and growing interest to the coal and the iron industries of Europe. The prospect of establishing railways in that part of the world at no distant date opens up a future fraught with the weightiest consequences to the commercial welfare of the European States.

The fact that every additional piece of information enlarges the extent of the coal fields already discerned, or reveals the existence of others not previously known, leads to the belief that in China we have a future competitor likely to become formidable in more than one of our staple productions. Baron Richthofen has published in a Vienna review some interesting particulars of the most recent discoveries in the search for coal now being diligently carried by geologists of several nations in the Celestial Empire. The Baron has himself explored fourteen out of the nineteen provinces into which China is divided, so that his statements may be accepted as at least approximately true. It appears from his account that not one of the nineteen provinces is wholly without coal; but the chief deposits are in the southern half of Chan-Si, in the South of Hunan, and in the west of Chan-Ting. The seams of Chan-Si alone cover an area of not less than 600 square miles, and contain, according to the Baron's estimate, 730,000,000,000 tons. As the total annual consumption of the world is about 300,000,000 tons, we have here enough to supply the demand for 2,433 years. The quality is that of an excellent anthracite, superior to that of Pennsylvania. In the southeast of the same province there is another basin of scarcely less extent, containing coal of a more bituminous character. This coal is already being largely worked. The produce, which is obtained by a costly system of working, is sold at the pits at a price of which three shillings a ton is about the equivalent. Baron Richthofen is of opinion that when these coal riches have been rendered available by the construction of railways, European capital will be attracted to China, and iron works and factories of all kinds will spring up in the neighborhood of this cheap fuel; and as a consequence the industry of the Western nations will be still further restricted. He might have added that the progress of socialism in Europe will tend powerfully to hasten this state of things by destroying the security of prosperity, and driving capital to seek a safer investment abroad.—*Iron and Coal Trade Review.*

THE HISTORY AND STATISTICS OF AMERICAN WATER WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E.; M. INST. C. E.

811. LANSINGBURG, N. Y.

Lansingburg, Rensselaer county, New York, in lat. 42° 44′ N., long. 73° 44′ W., is on the Hudson river, nearly opposite the mouth of the Mohawk river. It is named after its founder, Abraham J. Lansing, who settled at this point in 1771. It was incorporated a village in 1790. The soil is generally clay and the surface is undulating, sloping gradually to the west. Water-works were built by the village in 1884, after plans of P. H. Baermann, C. E., taking the supply from Oil Mill creek, which has drains three square miles, the water of which is impounded by an earth dam forming a reservoir holding 80,000,000 gallons, 265 feet above the town. The water is conveyed by a 16-inch cast-iron pipe to another reservoir holding 15,000,000 gallons at 194 feet above the town. Distribution is by thirteen miles of cast-iron pipes of from 12 to 4 inches diameter, with 315 taps, two meters and 119 fire hydrants. Service pipes are of lead. The ordinary pressure in the village is eighty pounds. The works have cost $160,000, which is the amount of the bonded debt at 4 per cent. interest. The cost of maintenance in 1885 was $8,000, and the revenue from water rates, $4,058.24. The daily consumption is not known. The population in 1880 was 7,432. The works are managed by five commissioners. John Brooks is the Superintendent.

WATER

THE Union Water-Works Company, Little Valley, N. Y. D. F. Rundell and others, incorporators.

THE Abilene Water Co., capital stock $60,000, has been incorporated at Abilene, Texas.

THE Racine, Wis., Water Company; capital, $5,000; incorporators, J. E. Dodge, F. M. Fish and J. W. Knight.

NEW gas-works are to be constructed at Fort Edward, N. Y. Address, N. R. O'Connor.

THE Easton Water-Works Co., Easton, Md., has let the contracts for building the works. The cost will be about $30,000.

THE Cobleskill Water-Works Company, Cobleskill, N Y. Capital stock, $25,000. Charles H. Shann and others, incorporators.

CORNING, N. Y., has authorized a system of sewerage. J. J. R. Croes, Consulting Engineer; H. C. Heermans, Construction Engineer. Partly separate system.

EAST ORANGE, N. J., has voted positively to build a system of sewerage. Some method of disposal other than turning into the streams of the neighborhood will be resorted to.

THE Clymer Water Company, West Indiana, and the Clymer Water Company, Indiana, Pa. Capital stock, $10,000. Treasurer, Henry W. Wilson; Attorney, Geo. W. Hood, Indiana, Pa.

THE Russell Water Works Company has been incorporated at Russell, Kan., with a capital stock of $50,000. The incorporators are William Blair, W. E. Banks, Thomas Acherman and others, all of Russell.

THE New York Health Board recently concluded analysis of artesian well water used to wash down beef in Chicago slaughter-houses, Swift & Co. and Armour & Co. It was declared unfit for contact with food.

THE City Council of Mitchell, Minn., has awarded the contract for a water-works reservoir, to be completed June 25. Three mains will be laid from the reservoir, furnishing fire protection for the entire town.

THE Palmer, Mass., Water Company at its annual meeting elected officers for the ensuing year: President, C. L. Goodhue; Treasurer, J. H. Gamwell; Clerk, C. K. Gamwell; Directors, James B. Shaw, F. R. Lawton, C. L. Goodhue, J. H. Gamwell and C. K. Gamwell.

CITIZENS of Waterloo, N. Y., propose to organize a water-works company to supply the village. Capital stock $40,000. The source from which water is intended to be supplied is wells sunk in or near the village, if a supply from such source be found obtainable, or from Seneca lake.

THE Pulaski, N. Y., water commissioners, having accepted the offer of E. D. Smalley, the engineer of the Canastota water works, to make an estimate of the cost of water-works for this village, he has looked the ground over, and made maps and a plan to present to the commissioners before the coming election. It is estimated that the works will cost about $20,000.

THE St. Louis Board of Public Improvements has appointed June 2d as the day for the opening of bids upon the work and erection of a new high-service engine at the water works. The board has also decided to establish the low-service extension from the Chain of Rocks and approved the plans for the work, and an ordinance was recommended which, if passed, will have the effect of giving the system a thorough test.

BOSTON, MASS.—The committee on drainage has made its first report on the report of the metropolitan commission. The bill provides that the State Board of Health shall have the general care of all inland waters, and may employ such engineers and clerks and other assistants as it may deem necessary, provided that no contracts or other acts which shall involve the payment of money from the treasury of the Commonwealth shall be made without an appropriation; it shall annually, on or before January 10, report to the General Court its doings in the preceding year, recommending legislation and suitable plans for such systems of main sewers as it may deem necessary for the preservation of the public health; said board shall have authority to conduct experiments to determine the best practical methods of purification of drainage or refuse arising from manufacturing and other industrial establishments. It shall from time to time consult with and advise the authorities of cities and towns, or with corporations, firms or individuals, either already having, or intending to introduce, systems of water supply of sewerage, as to the most appropriate source of supply, the best practicable method of assuring the purity thereof or of disposing of their sewage. All such new corporations, or individuals, are hereby required to submit for its advice outlines of their proposed plans or schemes in relation to water supply and disposal of drainage and refuse. Said board shall bring to the notice of the attorney-general all instances which may come to its knowledge of ommission to comply with existing laws respecting the pollution of water supply and inland waters, and shall annually report to the Legislature any specific cases not covered by the provisions of existing laws which in its opinion call for further legislation.

ROCKLAND, MASS.—Work has been begun upon the stand-pipe which is to supply the towns of Rockland and Abington. The pipe will be the largest in this section of the country, holding 300,000 gallons and weighing 1,500 tons. It is to be made of steel. The water will be pumped through a 16-inch pipe from the Big Sandy pond in Pembroke, five miles distant. The water in the stand-pipe will be 230 feet above the surface of Big Sandy, and 129 feet above the highest point in Rockland. Twenty-two miles of pipe will be laid.

W. H. WHEELER, contractor, and T. J. Pursell, of Portsmouth, O., have an extensive ditch contract in Iroquis county, eastern Illinois. Their contract is for the construction of thirty miles of ditching to drain the farm lands: the ditch is to be 72 feet in width and from seven to nine feet deep. The contract, which was awarded by the State Drainage commissioners, calls for the removal of about 358,000 cubic yards of earth, and will amount to between $40,000 and $50,000. They will have two steam dredges at work, and it will take them about eight months to complete the contract. They will probably sub-let a portion of it.

ARTESIAN WELLS IN CENTRAL ASIA.—At the invitation and expense of General Annenkoff, the constructor of the railway to Merv, Herr Grote, with a staff of Russian assistants, has been conducting some successful experiments in artesian well boring along the course of the Transcaspian line. The worst part of the new railway route to Central Asia is the section of thirty or forty miles inland of Port Michaelovsk, where the Caspian seems to have receded and left a belt of more or less arid sand. To convey water to the stations and watch-houses along this desert strip, General Annenkoff, it may be remembered, laid down an English pipe-line last autumn. Commencing here, Herr Grote succeeded in reaching water at different places at 70 feet, and subsequent investigations have demonstrated that it will be possible not only to furnish a supply sufficient for the railway, but also for purposes of cultivation.

It is well that this fact should be appreciated by those politicians and officers who overlook the important *role* that is being played by engineering in the race of empire expansion. Only a short time ago Mr. Charles Marvin stated that the competition between Russia and England was no longer a "conflict between the slow Russian camel of the Asiatic steppes and the swift English steamer, but between the rapid Russian locomotive and the slower English steamer." Yet, completely ignoring the extension by railway of the magnificent line of communication afforded by the Volga and Caspian, Lord Charles Beresford more recently advocated that England should still further handicap herself by resorting afresh to the roundabout Cape route.

In the columns of a military contemporary, again, there has been a controversy between General Kaye and others with reference to the difficulties Russia would encounter in marching from Herat to Candahar, which curiously illustrates the incapacity of officers of the old school to realize the services engineering can render to an enterprising foe. To General Kaye the occasional bits of wilderness lying between Herat and the river Helmund, constitute a tremendous obstacle, and he seems unable to conceive that a waterless march can have its rigors easily and rapidly mitigated by the use of pipe lines and artesian wells, as already employed in Central Asia, and the difficulty done away altogether by covering the barren expanse with a railway.

By establishing a series of artesian wells, and doubling and trebling the expanse of irrigation stretching from the Caspian to Penjdeh, Russia, will very soon secure for herself large local resources, and the effort she is making to do this should be a warning to those who forget what similar activity could achieve between Herat and the Helmund. We question whether in the Russian advance the engineer is not becoming a far more potent factor than the irrepressible Cossack.—*Engineering.*

FAIRMONT, NEB.—An experimental test of the water-works was made recently; at which a 1-inch stream was thrown to a height of about 75 feet.

BRIDGEPORT, CONN.—It is said that the new water supply from Mill river will be brought into the city before October 1. The main reservoir will be five and one-fourth miles from the city, will cover fifty acres and will store 245,000,000 gallons. There are places further up stream where several other reservoirs can be built as required. The dam will be of masonry 40 feet high.

BUREAU county (Ill.) has fifty-five miles of graveled roads, outside of the villages; and the indications are that from this time on the "improvement" of the public roads will largely partake of this character. The farmers of this county have discovered that there is something better in this world than traveling through mud hub deep. Nearly all the roads in Princeton township are thus sustantially improved, the progressive people elsewhere in the county are fast "catching on." Spread the gravel.—*Bureau County Republican.*

WATER-POWER FOR DENVER.—A project for furnishing Denver, Col., with cheap motive power is now receiving some consideration. It is to confine the Platte river within narrow limits, similar to a large flume. This can be done by piling and planking sides and bottom. Over this flume to place a large "undershot" water-wheel, which can be driven by the force of the current striking against its paddles. By making the wheel 100 feet long, the width of the flume, and about fifty feet in diameter, it is thought that an immense power could be obtained, which could be used for local manufacturing establishments, and for the electric lighting plants.

CAPE MAY, N. J.—There has been great dispute over the water-works, one party declaring the water unwholesome and desiring to sell the works, the other party claiming the water to be good in quality, and sufficient in quantity. The dispute was settled May 7th, the Council resolving to extend the water-works so that the supply shall be obtained from the mainland. This, of course, involves a rejection of the project for the sale of the water-works to a private corporation. In order that the change may be made before the summer season opens, the Water Committee was authorized to prosecute the work at once. A bid was received from R. D. Wood & Co. for doing the work. The Council also adopted resolutions condemning recent publications alleging that the water supply was impure, and inadequate, and censuring the city officials who had given out those reports or endorsed them.

LINCOLN, ILL.—The pipe for the water-works is being delivered. Instead of taking the water supply from Smith's Ford, it is now proposed to take it from a well at a point much nearer, or only 800 to 900 feet above the Rubicon. Objection is made that this will endanger the supply from the city sewage, but the engineer in charge is confident that this cannot create trouble because of the intervening distance and the strong current of the creek. He says the gravel through which it is proposed to sink the well, is as clean as can be found anywhere and that it will make a first-class filtering bed. Whether the well alone will give a sufficient supply without running a filtering gallery to the creek can only be known after a test with the steam pump. A main 14 inches in diameter, and 2,235 feet long will lead from the well to the pumping works.—Lincoln, Ill., *Herald.*

IRRIGATION IN TEXAS.—Irrigation as it is seen in the valley of the Rio Grande and elsewhere means a system of ditches, which the Mexicans introduced here, and which they had from the Jesuit priests of old Spain, the leading out of water from the rivers to the fertile valley to overflow or flood the soil to be tilled. The Rio Grande is our "American Nile." The similarity is complete; the analogy remarkable. The water of the river comes from the snowy mountains of San Juan county—just as the Nile from the mountains of Abyssinia. The melting of the snows causes the river to rise with almost clock-like regularity between the 1st and 5th of May. The canals or ditches are cheaply and easily made, and usually extend, as the Mexicans made them, from two to fifteen miles. In their construction several pueblos join. When reaching the land to be irrigated, each farmer has his own private canal, which conveys the water to every foot of his growing crops. This would seem costly to one unacquainted with the method, but the main canal costs less than six (?) dollars per ten miles, and a canal ten miles long will irrigate ten thousand acres, with repairs not exceeding fifty cents an acre a year. With this small expenditure, two or three crops can be grown each year, with a less cost of cultivation.

RIPARIAN RIGHTS.—Following is the syllabi of the decision in the water right suit of Lux & Miller *vs.* the Kern Land and Canal Company (Haggin & Carr), which has been prosecuted to obtain a decree enjoining the defendant from diverting waters of Kern river:

The question being: 1. Can a private corporation divert the waters of a water course and thereby deprive the riparian proprietors of all use of the same, without compensation made or tendered to such proprietors? Held, the owners of land by or through which a water course naturally and usually flows, have a right of property in the waters of the stream.

2. This property may be taken for a *public use*, just compensation being first made, or paid in Court. Water to supply "farming neighborhoods" is a public use, and it is for the Legislature to determine whether in the exercise of the power of eminent domain, it is necessary or expedient to provide further legal machinery for the appropriation (on due compensation of private rights to the flow of running streams and the distribution of waters thereof to public uses).

3. But one private person cannot take his property from another, either for the use of the taker or for an alleged public use, with any compensation paid or tendered. (Cont., Art. I., Sec. 14).

4. Riparian owners may reasonably use water of the stream for purposes of irrigation.—Sacramento, Cal., *Record-Union.*

NEWS OF THE WEEK.

CONTRACTING.

Paving.—West avenue, Buffalo, N. Y., is to be paved with Medina stone and Ferroid during this season.

Sewer.—A sewer is to be laid on High street, Middletown, Conn. Cost about $2,923.

Culverts.—The culverts in Athens, Ga., are badly put down, and it will take at least $40,000 to get them and the streets in good order.

Paving.—The bids for grading Plato avenue, St. Paul, Minn., were all rejected as too high. The work is to be readvertised.

Reservoir.—The reservoir contract at Beverly, Mass., that was given up has been awarded, this time to Hill, Ellingwood & Berry for $18,904, and will be commenced at once.

Tower Bridge.—John Jackson has been awarded the contract for the construction of the abutments and piers of the new Tower Bridge over the Thames at London, England. The price is $656,720.

City Hall.—Messrs. Waite & Cutter, architects, are the successful competitors for the design of the City Hall, Richmond, Va. Bids for construction have been advertised for.

Iron Bridge.—The bids for erecting the bridge at Clyde have been considered by the Warwick, R.I., Town Council but not yet awarded. The contract for the stone work has been awarded to Patrick McMahon.

Competition of Architects.—Supervising Architect Bell, Washington, D. C., is in favor of the principle of the bill offered in the House by Mr. Hewitt, opening to general competition designs for all public buildings costing more than $50,000.

Sewers.—The following contracts have been awarded at Montreal: Berri street, B. McKeown, sewer, $5.19; rock, $3.75. Rolland lane, F. Brackin, sewer, $4.50; rock, $3.50. Aqueduct street, F. Brackin, sewer, $5.10; rock, $3.20.

Jail.—The P. J. Pauly Jail Building and Manufacturing Company, of St. Louis, have been awarded the contract for the erection of a brick fire-proof jail at Tallulah, Madison parish, La., on a tender of $6,999.45. The cells and all other metal work are included, and the structure is to be ready for occupancy by October 1.

Coney Island's Sewer System.—Supervisor McKane and his associates on the Gravesend Health Board, May 3, formally broke ground as a signal for beginning the construction of Coney Island's sewer system. The contractors have their material largely on the Island and promise to push the work actively forward.

The Little Rock and Memphis R. R. will change its gauge on the 30th inst., from 5 feet to 4 feet 8½ inches, to correspond with the Louisville & Nashville, Memphis & Charleston and East Tennessee, Virginia & Georgia systems, which will all be changed about the same time. This will make all roads centering at Little Rock, Ark., of uniform gauge.

Pipe.—The contract for the 8 and 10-inch pipe for the Ohio Gas Fuel Company, to be laid from the Pennsylvania State line to Youngstown, O., has been awarded to Matheson & Son, of Middletown, Pa., who are now building a large plant at Youngstown for the manufacture of pipe. The delivering of the pipe to the gas company is to commence on June 1, and a large force of men will be put to work laying the two mains.

Kansas, Nebraska & Dakota R. R.—The contract for grading ten miles south of Topeka, Kan. has been let to Samuel Dolman.

Texas & St. Louis R. R.—The embankments and cuttings are to be widened preparatory to changing the gauge of the road. Proposals for the work, which will be let in divisions varying from six to seventy-four miles in length and requiring from 15,000 to 138,000 cubic yards, will be received by the special chief engineer, Richard P. Morgan, at Cairo, Ill., until May 17th. The work is to be completed by September 1st.

Stone Arches.—Bids for the construction of stone arches, at Herkimer, N. Y., where the present wooden flood bridges stand, were as follows: Joab Small, $4,999.99; Mosher & Todd, $5,118.75; Ford & Kretzer, $5,990.81; V. Brown, $5,995; Thomas Nugent, $4,965.50; Charles Brown, $6,287.50; John Nelson, $6,314. The commissioner, W. W. Borse, awarded the contract to Ford & Kretzer, but it was afterwards reconsidered.

Brick.—J. J. and Col. Hoblizell have contracted to furnish the Baltimore & Ohio R. R., with between 5,000,000 and 6,000,000 bricks to be used this season in arching the six tunnels between Washington and Wheeling. The contractors have leased the requisite ground at Finleyville, on the B. & O. R. R., and will put up extensive works there at once. Their works will have a daily capacity of 30,000 bricks.

Water Supply.—The Treasury Department recently advertised for bids for sinking wells to supply the Assay Office, Wall street. Apparatus intended to overcome the nuisance long complained of growing out of the sulphurous fumes generated in assay-office operations has been completed, but is found to require a greater water supply than can be furnished by the city, and consequently to require the sinking of wells on the premises. The water is needed to supply condensers, and it is estimated that sixty gallons per minute, or 27,800 gallons per day are necessary for the purpose.

Bridge.—The Commissioners of Muskingum county, O., have decided to build a bridge across the Muskingum river at Gaysport. It was ordered by the Board that the auditor advertise for proposals immediately. The structure will be 600 feet long, with a wagon road 16 feet wide in the clear, and a foot walk 4 feet broad on one side. The bridge is to consist of four spans resting on abutments and piers and will be above high water mark. Proposals for both iron and wooden bridges will be invited, each bidder to furnish his own plans.

Street Work.—The following is the approximate estimate of City Engineer Churchill, of Galesburg, Ill., of the cost of grading, curbing, sewering and paving with brick, Main street from Seminary street to the Chicago track of the C. B. & Q. R. R.:

Total length of pavement	1,089 feet
Cost curbstone, 2,166 feet	$1,472 88
Grading, 2,238 cubic yards	559 50
Sewer pipe, 2,178 feet, 12-inch	653 40
Brick pavement, 6,714 square yards	9,399 60
Four catch-basins	160 00
Four lamp-holes	10 00
Contingencies	304 60
Total	$12,500 08

This was referred to the Street Committee.

Atlanta, Greenville & Western Narrow Gauge R.R.—The company has made a contract with Alexander Stuart & Co., for the grading of the road from Ninety-Six, S. C., through Abbeville and Edgefield counties to Johnston, in Edgefield county, on the Charlotte, Columbia and Augusta Railroad, a distance of thirty miles. A contract has been made with Sullivan & Co. for the grading from Johnston to Hamburg, the Carolina terminus of the South Carolina railroad bridge over the Savannah to Augusta. The road is now under contract from Augusta to the Saluda river, at Ware's Shoals, a distance of seventy-four miles. Captain Kirk, Chief Engineer, is positive the grading over this distance will be completed by September 1st. Stuart & Co. begin work from Ninety-Six to Johnston on the 15th.

Railroads, Bridges and Canals.

The Georgia Pacific R. R. Co. will complete the gap between Birmingham, Ala., Columbus, Miss., by January 1, 1887.

Southern Pacific R. R. surveyors have started from the end of the new Yosemite branch to lay out a road over the mountains into Nevada.

The Norfolk & Western Railroad Co. is extending the New River branch seven miles. The contract has been let to George M. Evans, Roanoke, Va.

Wellington's "Economic Location of Railways." W. E. Pettee, C. E., Lakeville, Conn., has a copy of the old edition of this work which he will sell.

The Newton & Northwestern R. R. Co. has been incorporated in Kansas to build from a point in Harvey county to the western State line. Estimated length, 300 miles. Capital, $4,500,000.

Mixed Gauge.—The track of the St. Clairsville, O., Narrow Gauge R. R. is receiving another rail, so that standard gauge cars can hereafter be used.

Dakota Railroad Extension.—IPSWICH, Dak., May 3.—Work on the extension of the railroad from Ipswich to Roscoe began here to-day. The cars are to be running in ninety days.

The East New York, Bay Side & Ozone Park Railroad Co. is about to start laying its tracks through that section of New Lots, L. I., which its charter calls for.

Northern Pacific R. R. Extension.—HELENA, Mont., May 5.—A corps of engineers left here to-day to survey a line for the extension of the Wickes branch of the Northern Pacific R. R. to Butte.

Kansas City, Fort Scott & Gulf R. R.—WASHINGTON, May 8.—In the House of Representatives, this morning, a bill was passed authorizing the company to construct a road through the Indian Territory.

Hartford & Connecticut Valley R. R.—It is thought desirable to straighten out some of the kinks of this road, and plans are under discussion with that end in view. The line is gradually to be equipped with iron bridges.

Fremont, Elkhorn & Missouri Valley R. R.—Tracklaying was commenced at Chadron, Neb., April 26, and will be completed to the Wyoming line; it has also been commenced on the Black Hills branch and will be completed to Rapid City.

Hatteras Ship Canal.—Several members of the House Committee on Railways, Commerce and Canals, have been inspecting the sounds and inland waterways of North Carolina, with a view to the possibility of a ship canal on the inside of Hatteras.

The Huntington & Ohio Valley Railroad Co. has been incorporated at Columbus. It is supposed to mean a railroad bridge at Huntington and a road down the Ohio side of the river to Petersburg, Lawrence county, connecting with the Scioto Valley R. R.

Filling up a Pennsylvania Canal.—The bed of the Union canal, for many years an important waterway between the Susquehanna and Schuylkill, is being filled up between Lebanon and Myerstown by the Berks and Dauphin Turnpike Company, and a substantial road is being constructed.

The Lake Superior, Ortonville and Southwestern Railway Co. has been incorporated at St. Paul, Minn. Capital stock, $3,000,000. The incorporators are Paul Hauser, Sr., Frederick Gutterson and J. K. Riley, of St. Paul; C. E. Brooks and Samuel Burdock, of Ortonville, Minn.

South Florida R. R.—The gauge of this road from Sanford, to Tampa, will be changed from 3 feet to standard about June 1. Arrangements have been made with the Jacksonville, Tampa & Key West R. R., by which as soon as the gauge is changed, through trains will be run between Jacksonville and Tampa.

Chicago, Iowa & Pacific R. R.—Tracklaying was begun May 4, at Fredrika, Bremer county, Ia. The line is to run in a southeasterly direction, and its terminus will be Anamosa, Jones county. Although built by a construction company, it is undoubtedly a Chicago & Northwestern enterprise.

Piedmont and Cumberland Railway Company.—The road is to run from Piedmont, W. Va., along the north branch of the Potomac river to a point in Mineral county, W. Va., opposite the city of Cumberland, Md. Capital stock, $500,000. Ex-U. S. Senator H. G. Davis, of Mineral county; Stephen B. Elkins, New York; and others are interested.

The Decatur and Ohio River Railroad Co. has been incorporated at Indianapolis, Ind. The following are the directors: C. W. Fairbanks, Otto Gresham, Samuel P. Scott and J. H. Deane, of Indianapolis, and G. C. Wattles, of New York. Capital stock, $750,000. The projected road extends from Fort Wayne to Willshire, O.

Carthage & Harrisville R. R.—Work has been begun on this road, which is to run from Carthage, N. Y., on the Utica & Black River R. R., southeast to Fine, a distance of about forty miles. A branch is also to be built from a point near Harrisville to the mines of the Moquette Iron Ore Co. The road will use the grade of the old wooden railroad, built many years ago to reach the Harrisville mines, but long since abandoned.

Steel Ties.—The French Government has decided to discard the use of wooden ties on the State Railways, and to gradually substitute metal ones. The Minister of Commerce has invited tenders for 25,000 steel ties to begin with; but it is calculated that 4,300,000 will be required every year for fifteen years before the whole of the existing mileage will be replaced. At present prices this means an expenditure of about $8,000,000 per annum upon steel.

Middle & East Tennessee R. R. Co.—A meeting was held at Hartsville, Tenn., April 27 and the following board elected: President John A. Fite; Vice President, W.A. Caruthers; Secretary, H. H.Pickering; Treasurer, W. A. Reeves; Directors, W. H. Young, J. D. Allen, W. S Munday, D. B. Anderson. The directors were instructed to bond the road for $20,000 per mile and negotiate for its construction. A bid was received from a construction company. The line will run from Gallatin to Carthage by way of Hartsville.

Detroit River Tunnel.—A civil engineer recently stated that work on the railroad tunnel was stopped on account of lack of funds owing to the opposition of railway men, who hoped by killing the tunnel to get a low bridge across the river. When the enterprise was abandoned the working parties were right in the finest kind of hard-pan and had only about 300 feet further to go to bring the two sections together. It was his opinion that the work is still in good condition.

Narrow Gauge Railroad in Maine.—Mr. George E. Raymond, of Portland, Me., is making a survey for a narrow gauge railroad through the Notch of the Bartlett mountains, from near Frank George's Hotel to the Swift river intervale, a distance of from six to eight miles. It is estimated the road will cost from $8,000 to $12,000 a mile. When the survey is completed a company will be organized. This road will be a valuable feeder to the Portland & Ogdensburg.

The Market Street Bridge.—An ordinance has been submitted to the Survey Committee, of Philadelphia, by the Chief Engineer and Surveyor, relative to the proposed expenditure of $300,000 to build a permanent iron bridge over the Schuylkill river at Market street. The structure is to be at least 75 feet wide, and if possible to have its spans extended on the piers now standing. It is also provided that the necessary tracks and conduits for the cables of the Traction Company shall be included in the expense, the company to reimburse the city by tolls collected annually on each car passing over the bridge. Objections were made to this method, but the committee concluded to accept the Chief's suggestions.

The Montreal Floods.—The Dominion authorities have appointed two civil engineers to investigate and report upon the cause of the floods which of late have caused so much damage to the city and vicinity. Mr. Thomas Guerin, C. E., and Mr. Simon Lesage, C. E. it is understood, will immediately commence the investigation with a view of embodying in a report such recommendations as they may make after their survey is completed. Both banks of the river are to be included from La Tortue to Longueuil on the south and from the foot of the rapids to Hochelaga on the north. The engineers will, during the investigation, consult with Mr. Lesage superintendent of the water works, Mr. St. George, the city surveyor, and with Mr. Kennedy, harbor engineer.

Nova Scotia Railroads.—HALIFAX, N. S., May 4.—By the Provincial Government railway policy, submitted to the Legislature to-day, all Canadian and American propositions are rejected and the English syndicate scheme, worked up by C. A. Scott, of Quebec, accepted. The syndicate is known as "The Joint Stock Association," and is composed of the following English capitalists: J. W. Johns, M. P., Wm. Eckersley, Brinsley de Courcy Nixon, R. J. Price, A. W. Watson, R. G. Elwes, G. W. Owen and F. F. Piggott, associated with the following Nova Scotians: L. E. Baker, Jacob Bingay, H. H. Fuller, John S. McLean, William Esson, Adam Burns and Charles A. Scott. The syndicate is to raise $5,000,000 and, aided by the Local Government, acquire the Windsor and Annapolis, the Western Counties and the Windsor branch railway, with running powers over a portion of the Intercolonial R. R. They are to build the "missing link" between Annapolis and Digby, and thus have a through line between Yarmouth and Halifax. The estimated cost of the acquisitions and construction is about $2,500,000. They may also acquire the Nictaux & Atlantic Railway and build lines between Yarmouth and Shelburne and Windsor and Truro. C. A. Scott is to be General Manager of the system. In case of failure of the syndicate to carry out the agreement, the Provincial Government are to have the first lien upon and take over the roads. The Government also proposes to aid the construction of a trunk line from the Strait of Canso to Sydney or Louisburg with 2 800 acres of Crown lands and $3,200 per mile, not exceeding $256,000, in addition to the $6,400 per mile Dominion subsidy, and offers $6,200 and 2,000 acres land per mile to any company building any projected railway in Nova Scotia. In case no company undertakes the construction of the through line in Cape Breton, the provincial subsidy will be given for sections of fifty miles each. A railroad is projected from Truro, Colchester county to Windsor, Hants county. The distance is about fifty miles, and the route is direct. The most expensive feature of the enterprise if undertaken would be the bridging of the Shubenacadie river, which divides the counties.

The St. Gabriel Levee and Railway Company has been incorporated to construct a levee along the bank of the St. Lawrence, at Montreal, and lay a railroad thereon. The levee is for the protection of the city against future inundations. The company must permit other railroads to lay their tracks on the levee.

The Fort Smith, El Dorado & Northwestern R. R. Co. has been incorporated in Kansas to build a line northwest from a point on the southern State line. Length, 300 miles; capital, $5,000,000. Directors, Warren B. Cook, Julius M. Turner of Columbus, Ind., Russell H. Rugg, of Appleton, Wis., Frank Bowen, of El Dorado, John M. Diles, of Leon, and John Gamble, of Elk Falls.

Tunneling.—F. O. Brown, of this city, has recently patented a new form of tunneling machine. A shell the size and shape of the tunnel is closed by an air-tight partition; through this passes a large tube containing a spiral conveyer, with a cutting edge at its outer extremity. The machine is forced forward by air-pressure.

Chicago, St. Louis & Western R. R.—This is the Chicago extension of the old Chicago, Pekin & Southwestern R. R. The line from Pekin to Springfield is being graded now and will reach Springfield by September 1. It will parallel the Peoria, Decatur & Evansville R. R., probably to Green Valley, and run thence almost on a sectional line to Springfield. The distance from Chicago to Springfield will be 198 miles or less, and the extreme distance by it when completed from Chicago to St. Louis will be 291 miles.

Fall of a Bridge.—The new iron bridge being built at Lyonsdale, Louis county, N. Y., gave way May 8th, precipitating seven workmen and a wreck of twisted iron into the Moose river, 30 feet below. Two men escaped by jumping on a pier. One workman, W. H. Wilcox, of Port Leyden, in leaping to an abutment lost his foothold and was fatally injured. The others swam ashore, although some of them had sustained severe injuries. The accident was caused by the giving way of a temporary trestle.

Chesapeake, Ohio & Southwestern R. R. Co.—In a recent suit in which the company was indicted in two cases for obstructing travel in the public roads by a failure to repair the bridges built by the railroad over cuts made to construct the road across public roads: it was held: That the company had only to have the road in good condition when they first placed bridges across their cuts and were not obligated to keep the same in repair or rebuild in the event of their becoming so defective as to be unsafe for travel. The cause was decided upon a construction of the charter of the company.

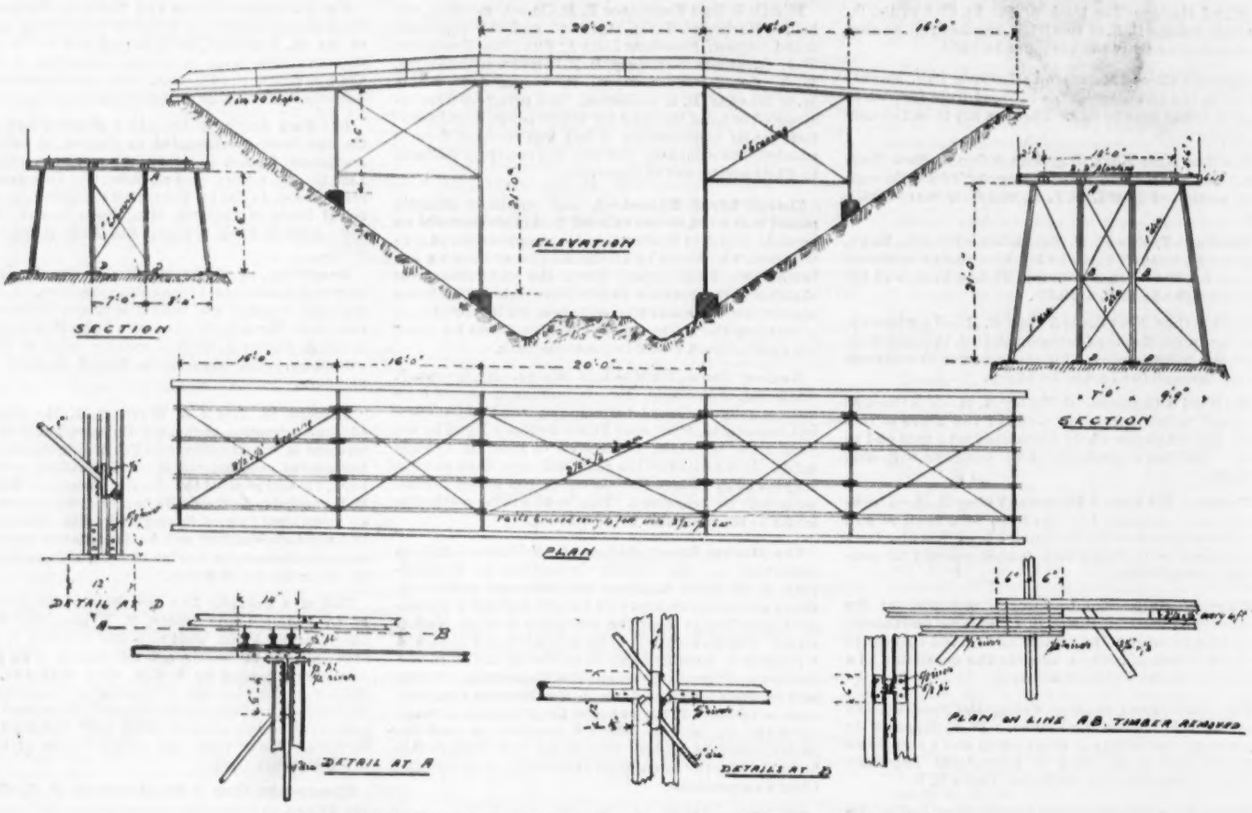
New York Legislature.—The Assembly has passed the Albany Water bill and bills for a system of sewers in Mount Vernon, appropriating $200,000 to lengthen five locks on the Erie canal at Syracuse, preventing the building of any railroad on the State reservation at Niagara Falls, and appropriating $5,000 for the improvement of the Oswego river. The Senate has passed the New York Aqueduct bill, and the bill for a bridge over the Black river at Gregg. The Governor has signed the bills providing for draining and filling up the abandoned Chemung canal and authorizing the sale of the Prospect Park & Coney Island R. R. to the Atlantic Avenue R. R. Co.

Michigan Railroad Extensions.—W. C. Ransom, Deputy Commissioner of Railroads of Michigan, states that about 400 miles of railroad will be built this year, subject to the outcome of the labor troubles. The extensions are approximated as follows:

	MILES.
Minneapolis, Sault Ste. Marie & Atlantic	170
Detroit, Bay City & Alpena (N. G.)	80
Toledo, Ann Arbor & Northern Michigan	50
Grand Rapids & Indiana	38
Lansing, Alma & Mt. Pleasant	20
Saginaw, Tuscola & Huron (N. G.)	20
Detroit, Lansing & Northern	12
Total	390

The Huntington System of Railroads.—Following is a list of the roads and steamships in the Huntington system, with the mileage of each:

	Miles.
Central Pacific	1,650
Southern Pacific of California	757
Southern Pacific of Arizona	334
Southern Pacific of New Mexico	167
Galveston, Harrisburg & San Antonio	938
Texas and New Orleans	268
Louisiana Western	112
Morgan's Louisiana and Texas	281
Houston and Texas Central	522
Louisville, New Orleans and Texas	460
Chesapeake, Ohio and Southwestern	368
Kentucky Central	254
Chesapeake and Ohio	511
Elizabethtown, Lexington and Big Sandy	139
Cincinnati, Hamilton and Dayton	354
Total	7,135
Steamship lines	4,205
Grand total	11,340



Overhead Bridge for Gravel Road at Harriston, Toronto, Grey and Bruce R. R.

On the Utilization of Old Rails for Bridges and Trestle Work.

We give a sketch with details of a local bridge designed and erected by F. S. Williamson, late Inspector of Bridges on the Toronto, Grey & Bruce Railway, which will be of interest to our readers as the iron work consists of chiefly of old railway rails, which is certainly a novel way of getting rid of old track and not at a great sacrifice, for the strength practically remains the same, the weight being only slightly diminished after a constant wear and tear of years.

The bridge, after being painted, presents a handsome appearance, superior in many ways to the ordinary wooden road bridges of the present day, and where the rails can conveniently be obtained, will cost less. The drawings fully explain themselves in detail, and show at a glance the rigidity and simplicity of the design.

Patent Sewer Inlet Trap.

It would seem unnecessary in this age, to bring forward any argument in proof of the fact that it is an unsanitary and dangerous practice for city and town authorities to neglect the proper trapping of sewer inlets, thereby allowing an almost continuous stream of filthy and poisonous air to escape into the streets, nauseatingthe passer by, and filling the houses, (especially when situated near the street and their windows open) with germs of malaria fevers and diptheria. But there are still many places which need to have this important matter brought home to their municipal governments in strong terms.

It is well known that during the cooler seasons of the year the air in sewers is apt to be warmer than the outside atmosphere, especially after sundown. This warm air, together with the steam and hot water from numberless shops and dwellings, must produce a strong upward current through the sewer inlets, more particularly those on the higher levels. Mingled with this current of warmer air come the foul smells, and pestilential vapors which are continually being engendered in the sewers.

In places where the sewer empties into a river, the water of which is often low in the summer, exposing the mouth of the sewer, it frequently happens that a stiff breeze blows directly into the sewer, forcing the bad air back into the city.

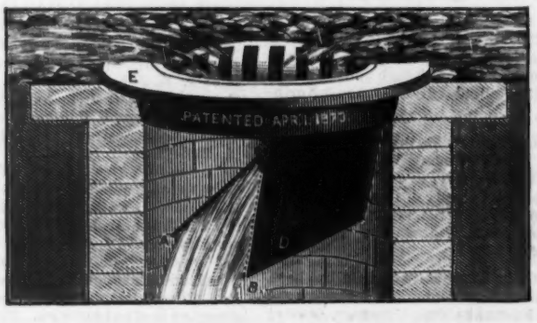
It therefore must be clear to any reasonable mind that this wholesale pollution of the air of our streets is most criminal and that it should be prevented at any cost.

With all the inlets trapped as they should be there will be little if any draft through the sewers and therefore much less forcing of gases into houses through their drains.

But in case it is thought best to ventilate the sewers it would seem the safest and best plan to build high chimneys in the unpopulated districts which would carry off all foul air to where it would be harmless.

Among the appliances invented for the purpose of closing the openings to sewers against the escape of gases, etc., may be mentioned the Hitchcock Patent Sewer Inlet Trap, manufactured by the Springfield Foundry Company of Springfield, Mass., in which city these traps have been extensively used and tested for about twelve years, accomplishing the object for which they were designed in an effectual and satisfactory manner.

Our illustration shows the operation of the Hitchcock Trap when surface water is entering the sewer; at other times the lid *A* remains tightly closed by its own weight. The spout *D* occupies only one half the opening and permits free passage of all the water which flows through the grating above it. The other half of the opening is closed by the shallow part o the trap, not shown in the cut.



Sewer Inlet Trap.

This trap is made of cast iron, is easily placed in the grate rim and can be removed as easily if necessary. It works as well in winter as in summer and has nothing about it to get out of order.

The manufacturers are referred to for further information.

THE Hamamisco Water Company is seeking to be incorporated by the Massachusetts Legislature, to supply the town of Grafton with water. The bill of the incorporation permits the company to hold $10,000 in real estate, and to issue $30,000 in capital stock.